SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

1912

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
[No. 26a—1913] 1913 No. 224

To His Royal Highness the Duke of Connaught and Strathearn, K.G., etc., Governor General of Canada.

May it please Your Royal Highness:

The undersigned has the honour to lay before Your Royal Highness, in compliance with 6-7 Edward VII, Chapter 29, Section 18, the Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1912.

(Signed) LOUIS CODERRE,
Minister of Mines.

Hon. Louis Coderre,

Minister of Mines,

Ottawa.

Sir,—I have the honour to submit herewith, the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1912.

I am, Sir, your obedient servant,

(Signed) A. P. LOW,

Deputy Minister.

CONTENTS.

ILLUSTRATIONS.

Photographs.

Drawings.

Maps.

SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1912.

A. P. Low, Esq., LL.D.,
Deputy Minister,
Department of Mines.

Sir,—I have the honour to submit, herewith, the Summary Report of the Mines Branch of the Department of Mines for the calendar year ending December 31, 1912.

CHANGES IN STAFF.

Miss B. Russell, typewriter of technical reports, resigned on October 1, 1912.

A. A. Ellement, messenger, was, on July 22, transferred to the staff of the Customs Department.

The following additions to the staff of the Mines Branch were made during 1912:—

Norman L. Turner, M.A., appointed October 31, 1912, as assistant chemist.

H. V. Anderson, appointed September 16, 1912, as mechanical draughtsman.

Miss M. E. Young, appointed October 7, 1912, as typewriter of technical reports.

John H. Fortune, transferred September 3, 1912, from the Geological Survey Branch of the Department of Mines, as caretaker of building.

ORGANIZATION: CLASSIFIED LIST OF STAFF.

The following is a complete list of technical officers and other employees at present on the staff of the Mines Branch:—

Administration Staff:—

Miss J. Orme, secretary.
W. Vincent, filing clerk.
G. Simpson, mailing and distribution clerk.
Miss I. McLeish, typewriter.
Miss W. Westman, typewriter.
Miss M. E. Young, typewriter.
A. F. Purcell, messenger.
John H. Fortune, caretaker.

Division of Mineral Resources and Statistics:—

J. McLeish, B.A., chief of division.
C. T. Cartwright, B.Sc., assistant engineer.
J. Casey, assistant.
Mrs. W. Sparks, assistant.
Miss G. C. MacGregor, B.A., assistant.
Miss B. Davidson, typewriter.

Division of Fuels and Fuel Testing:—

B. F. Haanel, B.Sc., chief of division.
J. Blizard, B.Sc., technical engineer.
E. Stansfield, M.Sc., chemist.
A. H. A. Robinson, B.Ap.Sc., assistant engineer.

Division of Chemistry:—

F. G. Wait, M.A., chemist, chief of division.
M. F. Connor, B.A.Sc., assistant chemist.
H. A. Leverin, Ch.E., assistant chemist.
N. L. Turner, M.A., assistant chemist.

Ore Dressing and Metallurgical Division:—

G. C. Mackenzie, B.Sc., chief of division.
F. Ransom, B.Sc., assistant engineer.

Division of Metalliferous Deposits:—

A. W. G. Wilson, B.Sc., Ph.D., chief of division.
E. Lindeman, M.E., mining engineer.

Division of Non-metalliferous Deposits:—

H. Fréchette, M.Sc., chief of division.
H. S. de Schmid, M.E., assistant engineer.
L. H. Cole, B.Sc., assistant engineer.

Explosives Division:—

J. G. S. Hudson.
NOTE.—*This division will be fully organized on the passage of the proposed Explosives Bill.*

Draughting Division:—

H. E. Baine, chief draughtsman.
L. H. S. Pereira, assistant draughtsman.
A. Pereira, draughtsman.
H. V. Anderson, draughtsman.

OUTSIDE SERVICE.

Dominion of Canada Assay Office, Vancouver, B.C.:—

G. Middleton, manager.
J. B. Farquhar, chief assayer.
D. Robinson, chief melter.
A. Kaye, assistant assayer.
G. N. Ford, computer.
G. B. Palmer, assistant melter and janitor.

INTRODUCTORY.

The Mines Branch of the Department of Mines was organized primarily for the purpose of assisting, in a practical manner, the development of the mineral industry of Canada. This object is attained by the gathering and publishing of statistics, relative to the mining operations and economic mineral resources of the country generally; by initiating and conducting original research work, which aims at the commercial utilization of our metallic and non-metallic minerals; by mapping out magnetic ore bodies by means of magnetometric surveys; by defining the characteristics and, in well-equipped chemical laboratories, determining the properties of specimen ores and rocks. Results of the work undertaken are given to the public in the form of monographs on the scientific study of the ore deposits of Canada; and by the publication of reports and bulletins dealing with the investigation of certain processes. As examples of this latter branch of the work may be cited the electric smelting of refractory iron ores; the production of peat fuel; the economic extraction of zinc from refractory zinciferous ores, etc.

In planning, and in attempting to carry out the comprehensive programme of practical work, the chief aim has been to attract and to encourage the investment of local and of foreign capital in the opening up of promising mineral lands, and in the establishment of new industries. But in so doing, care has been taken not to encroach on the professional domain of private assay and testing laboratories, nor to attempt to supersede such special research work as may properly be conducted in the mining departments of our institutions of learning. The purpose in all cases is, not to compete with the practice of private and professional agencies, but rather to co-operate with them for the general good.

Since the establishment of the Mines Branch, valuable suggestions from mining, metallurgical, and chemical engineers have been received, and, where possible, have been acted upon. Advice of a practical character will always be welcomed from every quarter, for it is realized that only in this way, can a thoroughly efficient and progressive department be maintained.

An important feature of Mines Branch work consists in the systematic investigation of those mineral resources of Canada which, from a commercial standpoint, have hitherto been regarded as of but little practical value. As examples may be instanced the deposits of low grade titaniferous iron ores, and magnetic iron sands, on the one hand, and of peat and lignite on the other. Thus, a detailed report will appear shortly, which will deal with the preliminary investigation of the magnetic iron sands of Natashkwan, Que. This report will be followed by the publication of complete data on the subject.

The Ore Dressing and Metallurgical Laboratories have recently been considerably enlarged, and, when completed, will be in a position to carry through, either on a large or small scale, experimental tests on the dressing of the various Canadian ores and minerals. The experimental investigation of peat for domestic fuel and other purposes, has now been completed, and the Government peat bog at Alfred, Ont., sold to a Canadian syndicate. This syndicate has already spent large sums of money in the purchase of new machinery and plant, and expects to put 10,000 tons of air-dried peat fuel on the market in 1913. Moreover, in order that those of our central provinces which have themselves no coal resources, may secure the maximum efficiency in the economical use of peat and lignite for the production of producer gas for power purposes, the Chief-of-staff of the Fuel Testing Division, and his assistant, have been sent to Europe for the purpose of investigating the most recent developments in connexion with gas producer practice. With the information thus obtained, we in Canada will be enabled to commence at a point at which other countries have already arrived.

The experimental investigation of processes for the profitable reduction of the mixed zinc sulphide ores of Canada was begun in 1910, and is still being continued by the Mines Branch under the supervision of Mr. W. R. Ingalls. Elsewhere in this report will be found a statement by Mr. W. R. Ingalls, who briefly outlines the results of this work up to the close of 1912.

Inasmuch as Canada was the pioneer in the field of experimental investigation of electro-thermic smelting of refractory iron ores on a commercial scale, and especially as Canadian iron ores are largely of a refractory nature, it appears fitting that we, in this country, should continue to keep in touch with the rapid development now taking place in the science of electro-metallurgy. Consequently, as intimated in the Summary Report for 1911, a preliminary report on this subject was provided for and will be found on pages 94-120.

During the year 1912, disasters resulting from the use of explosives, and involving serious loss of life, occurred in various parts of Canada. It is gratifying to know that there is now a reasonable possibility that effective legislation, in the form of an Explosives Bill, will be introduced into Parliament during the present session. In 1910, this Explosives Bill was prepared by the Mines Branch, acting in conjunction with the Department of Justice. Owing, however, to the delay that has subsequently ensued, this Bill has not as yet been enacted. Consequently, the erection of the proposed Explosives Testing Station has been delayed, and the organization of an efficient Explosives Division held in abeyance. Upon the passing of the Explosives Bill, the erection of buildings, installation of necessary equipment and appliances, and the organization of a staff of capable inspectors, etc., will be undertaken at once.

During the year just closed, the pressing need of adequate office accommodation for the increasingly large staff of the Mines Branch and for the administrative staff of the Deputy Minister, has been recognized in a practical manner. On the first of May, 1912, the renovated building on the corner of George and Sussex streets was partially occupied. Subsequently, as the fitting up of the various parts of the building was completed, the respective Divisions of the Mines Branch vacated their temporary quarters in various parts of Ottawa, and took possession of their new offices. Owing to lack of funds, the completion of the commodious chemical laboratories on the third floor has been delayed; when, however, the rooms allotted to this important division are properly equipped, and occupied, the entire office staff of the Branch will be under one roof. As a consequence, the heavy handicap on the work of the Mines Branch, due in the past to unavoidable decentralization, will be removed, and its administration will, as a matter of course, become more efficient.

The programme outlined for 1912 constituted in many respects a continuation of work initiated in previous years. This, in the very nature of things, is presupposed; for, owing to the geographic extent of Canada, and the wide distribution of the economic minerals of the country, it is frequently impossible to conduct a systematic study without covering extensive areas. This necessarily implies much time, in certain instances requiring years.

A satisfactory result of the work done during the past year is found in the many expressions of appreciation received by the Mines Branch, for technical advice rendered, and for the investigation of promising mineral properties by competent field officers. This public service is always available for any legitimate enterprise, which has for its aim the development of the mineral industry of the country.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

The work of this Division, carried on under the direction of Mr. John McLeish, comprises the collection and compilation of statistics of the mining and metallurgical production in Canada, as well as the gathering and recording of information regarding the country's mineral resources.

A preliminary report on the mineral production of Canada in 1911 was issued on March 5, and the revised and final report was completed later in the year. Its issue was preceded, however, as usual by the publication of advance chapters issued as separate bulletins.

The following statistical reports have been prepared by the Division during the year:—

No. 150.—Preliminary Report on the Mineral Production of Canada during the calendar year 1911.

No. 181.—The production of Cement, Lime, Clay Products, Stone, and Other Structural Materials in Canada, during the calendar year 1911.

No. 182.—The Production of Iron and Steel in Canada, during the calendar year 1911.

No. 183.—A General Summary of the Mineral Production of Canada during the calendar year 1911.

No. 199.—The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada, during the calendar year 1911.

No. 200.—The Production of Coal and Coke in Canada, during the calendar year 1911.

No. 201.—Annual Report on the Mineral Production of Canada, during the calendar year 1911.

In addition to the above reports, the following lists of mine and quarry operators and clay manufacturers have been published:—

List of manufacturers of clay products in Canada.

List of stone quarry operators in Canada.

List of operators of lime kilns in Canada.

List of coal mine operators in Canada.

During the latter part of the year, Mr. C. T. Cartwright spent some time in eastern Ontario and Quebec, gathering information in connexion with the work of the Division.

The collection of statistics of mineral production during 1912 is at present being undertaken. A preliminary report will be issued during the first week in March, 1913, and will be included as an appendix to this report.

It will be remembered that the production in 1911 was somewhat adversely affected as a result of strikes by coal miners, and, through the shutting down of a large number of important collieries in Alberta and British Columbia. The reduced coal production in turn reacted in a restrictive way on the metalliferous production of British Columbia owing to the coke shortage. The total value of the production in 1911 was $103,220,994, as compared with $106,823,623 in 1910.

During the year 1912, the mining industry has been fairly free from disturbing elements, with one or two exceptions, and the result has been an output far in excess of that of any previous year. There has been an increased production of nearly all the important minerals obtained in Canada, and the aggregate value has been further increased by substantial advances in the average prices of most of the metals.

The development of ore bodies or ore reserves has been carried on with increased activity, and in many cases, with very satisfactory results.

Another important feature of the year's operations has been the tendency, so generally evident, towards improvement in metallurgical practice. Increased capacity and the installation of new equipment in many plants, particularly in the iron and steel industry, have also been marked.

Canada's rapid growth in population and industrial activity which has been a subject for comment for a number of years past, still continued, apparently unabated during 1912. This expansion has been the cause of a continued and steady demand for all those materials of construction obtained from the quarry, the lime kiln, the cement plant, and the clay manufactories, etc.

ORE DRESSING AND METALLURGICAL DIVISION.

During the first part of the year, the testing laboratory was operated for the experimental magnetic separation of ores received from Seven Islands bay, Que., and from Bessemer and Childs mines in Ontario. A small sample of ore from Carter, West Virginia, which was submitted by Mr. J. W. Evans, Belleville, Ontario, was also tested in a similar manner.

Mr. George C. Mackenzie, Chief of the Division, devoted the entire field season to a detailed examination of the deposits of magnetic iron sands which occur at Natashkwan, on the lower St. Lawrence. In carrying out this work, Mr. Mackenzie made use of an Empire drill and equipment. Mr. Ransom, assistant engineer, was, during this time, occupied in dismantling the old testing laboratory, and in preparing plans for the new laboratory now nearing completion.

During the past autumn, the installation of machinery for the new testing laboratory was commenced. This new installation, occupying a building 75 × 50 feet, will, when completed, include the necessary equipment for experimental ore dressing, either on a large or on a small scale. It will also have sufficient operative elasticity, to permit of the investigation of the majority of problems encountered in dressing Canadian ores. For information concerning conditions under which such tests are undertaken, application should be made to the Director of the Mines Branch.

DIVISION OF FUELS AND FUEL TESTING.

The work of this Division, during the fiscal year, consisted in the preparation of the monograph entitled "Report on the Utilization of Peat Fuel for the Production of Power," the testing of a sample of lignite from the Consumers' Coal Company, Moosejaw, and the chemical analyses and determination of the heating value of various samples of coals.

Commercial samples of lignite were obtained from five representative mines in the Province of Alberta, and these will be tested in order to determine their value as steam coals, and also when used for the production of power gas.

At the present time, extensive alterations are being made in connexion with the buildings and equipment of the Fuel Testing Station. Pending the completion of these alterations, the regular testing work at the Station is, for the time being, necessarily suspended.

With the installation of the experimental steam boiler, and the completion of the new chemical laboratories, the technical staff of the Fuel Testing Division will be in a position to undertake the work outlined in the Summary Report for 1911.

DIVISION OF CHEMISTRY.

Mr. F. G. Wait, Chief of the Chemical Division, reports that the laboratories have been working up to their fullest capacity during the year. Considerable progress has been made in the construction and fitting of the new laboratories in the remodelled office building on Sussex street. It is hoped that these new and much more commodious quarters will be ready for occupancy early in the coming year. With the present inadequate accommodation, the work of this Division is placed under a distinct handicap.

The working strength of the staff of chemists has been increased by the appointment of Mr. N. L. Turner, lately of the Bureau of Mines for Ontario, who comes to the Mines Branch with experience in other fields and in the same character of work as he will be called upon to carry on here.

EXPLOSIVES DIVISION.

The Explosives Bill formulated by the Mines Branch in collaboration with the Justice Department, and which has for its object the regulation of the manufacture, importation, and testing of explosives in Canada, was not reintroduced before the House of Commons during the session of 1911-12. The work of completing plans for the various buildings and equipment of the proposed Explosives Station at Ottawa was, however, continued. In furnishing detailed plans of the Explosives Testing Station recently erected at Rotherham in Yorkshire, the Explosives Department of the Home Office of Great Britain has assisted very materially.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B. C., DURING THE YEAR ENDING DECEMBER 31, 1912.

There were during the year 527 deposits of gold bullion, requiring 597 melts and 597 assays, including the assembling and remelting of the individual deposits after purchase into bars weighing about 1,000 troy ounces each, and the assaying of same. The net value of the gold and silver contained in deposits was $974,077.14.

In the Summary Report of the Mines Branch for 1911, attention was called to certain conditions which, up to the present time, have affected in an adverse manner the amount of bullion forwarded to the Dominion of Canada Assay Office at Vancouver. Suggested changes recently brought to the attention of this Department should, if adopted, add very considerably to the real value of this assay office.

INVESTIGATION OF PROCESSES FOR THE REDUCTION OF REFRACTORY ZINC ORES.

In the Summary Report of the Mines Branch for the calendar year 1910, the attention of the Federal Government was directed to the desirability of instituting an inquiry into modern processes for the extraction of zinc from refractory ores. At that time ample evidence was presented which established the undoubted benefit that such an investigation, if successful, would confer upon the zinc mining industry of Canada.

Acting on this suggestion, a sum of money was voted by the Dominion Government in 1910, to be devoted to an investigation of possible processes for the reduction of refractory zinc ores; for conducting experiments, and for such other purposes as may be deemed advisable for the promotion and manufacture in Canada, of zinc and zinc products from Canadian ores.

During the greater part of 1911 and 1912, work in connexion with this investigation has been conducted in the metallurgical laboratory of McGill University, Montreal, by a staff of metallurgists under the direction of Mr. W. R. Ingalls of New York. While this work has not as yet developed a process of treatment that can be considered as commercially applicable to the zinc ores of Canada, nevertheless the investigation has thrown much new light upon the principles of furnace design and has led us to condemn several types of electric furnaces that have been tried. The following statement, recently submitted by Mr. Ingalls, indicates the progress that has attended this investigation during the past year:—

DR. EUGENE HAANEL, NEW YORK, January 15, 1913.
Director of Mines,
Ottawa, Can.

DEAR SIR,—Experimental work upon the treatment of zinkiferous ores has been conducted during 1912 in the metallurgical laboratory at McGill University. Mr. Edward Dedolph has been in direct charge of this work and Dr. Alfred Stansfield has advised and occasionally assisted, the work being conducted under my general direction. Operations have been prosecuted steadily, save upon certain occasions when Mr. Dedolph was given leave of absence in order to attend to urgent personal affairs.

During the progress of these experiments I have made a careful examination of the literature respecting similar work elsewhere, have carried on an extensive correspondence with persons proposing new methods for trial, studying their data, etc., and have rendered opinions to you upon proposals that have been brought to your own attention and referred by you to me. Among these I have found nothing of promise in connection with the zinkiferous ores of Canada; nothing in fact that I have deemed worthy of experimental trial.

At McGill University the experimental work of 1912 was confined to electrothermic smelting. In this Messrs. Dedolph and Stansfield made 122 separate experiments during 1912, using 32 different forms of furnace, some of these, however, embodying but slight modifications.

At the request of the Secretary of the Canadian Mining Institute, I prepared, with your permission, and read at the meeting of that institute in Toronto, in March, 1912, a paper reviewing the then existing status of electrothermic zinc smelting. In the following paragraphs I shall necessarily be obliged to repeat some of the ideas and opinions expressed in that paper.

A commonly experienced difficulty in the electric smelting of zinc ore is the condensation of the zinc as powder, ordinarily called "blue powder," rather than as molten metal that may be tapped off and cast into molds. A certain proportion of blue powder is made in ordinary smelting, but in electric smelting this proportion has been far exceeded. In fact in many of our experiments at McGill University the condensation of zinc has been almost entirely in pulverulent form. Upon resmelting this powder spelter may be obtained, and in Sweden electric smelting is actually practiced in that way. During 1912 you requested my opinion respecting the advisability of inaugurating at Nelson, B.C., experiments upon the line of the Scandinavian method. I reported to you under date of February 6, 1912, that a translation of the Trollhattan results into Nelson terms showed a probable cost of smelting that would be prohibitive. Such work as is done at Trollhattan may in fact be done only under exceptionally favorable conditions. The conditions existing in British Columbia may not be thus characterized.

For successful electric smelting under ordinary conditions I am firm in the conviction that the avoidance of blue powder condensation, thereby escaping the necessity for extensive re-smelting, must first be mastered. Until that be done I see no use in undertaking any work upon a scale approaching the commercial. Holding this opinion the main thread of our experimental work at McGill University during 1912 has been that leading to the condensation problem.

Along with this, however, we have tried various systems of smelting, which may be broadly classified as (1) the smelting of high grade product, obtained by the pyrometallurgical concentration of low grade ores; and (2) the direct treatment of low grade ores. By the first method the zinc is burned from the ore in an ordinary air furnace and the residuum discarded therefrom, the zinc-oxide fume being passed on to the electric furnace. By the second method no preliminary treatment is given to the ore and the worthless constituents thereof are drawn off from the electric furnace as slag. We have experimented also with such ore as is ordinarily treated by the zinc smelter in conventional practice, with the redistillation of blue powder, and with the smelting of raw sulphide ore. In all of this work, however, we have had a good deal of trouble in condensation and I do not regard that problem as being satisfactorily settled yet, but we have gradually obtained improved results and in some recent experiments have obtained rather high proportions of spelter in the form that we want, and I am consequently hopeful that this particular problem will be mastered ere long.

The formation of blue powder in the zinc condenser appears to be due to both physical and chemical causes. Under certain conditions of temperature, vapor pressure, etc., zinc may condense as powder and pellets, just as aqueous vapor may condense as snow and hail. This kind of powder may be melted, as we have sometimes done in the laboratory at McGill. If, however, the powder be superficially oxidized or otherwise affected chemically it may not be possible to fuse it at all. Such chemical action must therefore be avoided.

The studies at McGill have led me to believe that an essential condition to the condensation of zinc from the electric furnaces is purity of the gas and vapor, including freedom from all but a small modicum of carbon dioxide and freedom from vaporized impurities. The gas coming directly from the electric furnace is higher in carbon dioxide, as we have found by repeated determinations, than is permissible. This has been corrected by passing the gas and vapor through a column of incandescent carbon, called a "secondary reducer." The action of this is ameliorative, I think. We have generally obtained a better condensation with the use of this adjunct; but even when the gas is thus cleaned of carbon dioxide we still experience a certain collection of blue powder, that we suppose to be due to vaporized impurities, which we are now endeavoring to control or avoid.

In early experiments we had much difficulty in managing the secondary reducer, but gradually it was learned how to do that. Similarly, experience has been gained in the matters of feeding and management generally, and in details of construction. The main types of furnace tried during 1912 were of the resistance and arc-resistance principles, both of these being modified in many different ways; such as vertical electrodes and horizontal; passage of current through charge as resistor, passage through carbon, and passage through slag; secondary reducer arranged internally and externally; different arrangement of condensers, etc.; change after change being made with the hope that some particular difficulty would be circumvented. This, of course, is the natural course of experimental work. The furnaces used in the recent experiments have smelted about 200 lb. of charge in 24 hours.

We have in the main used roasted ore purchased from zinc smelters in the United States, this serving as well as any other ore for the determination of what we have been aiming at and saving us the trouble and expense of ourselves roasting ore. Besides we have been able to obtain a product commercially roasted and better done than we could accomplish in a small furnace. In conducting our electric smelting experimentation at McGill University we have had the advantage of a laboratory well provided with electrical equipment, besides the use of necessary scientific instruments, and the services of analytical chemists and draftsmen Although we sometimes are cramped for room and are delayed by collegiate necessities, we probably could not on the whole find elsewhere such conveniences as we have enjoyed there.

Besides our own work in electric smelting a large amount of experimental work during the last ten years has been done by others. A good deal of such work was done during 1912, among others by Specketer, Thierry, Cote and Pierron, Johnson and Petersen; and by the Vieille Montagne Company. At Trollhattan, Sweden, electrothermic spelter was produced commercially. The results in the smelting of 537 metric tons of ore in 1911 were reported by F. W. Harbord. According to him the average power consumption per ton of ore was 2,078 kw.; this relatively high figure being explained to a large extent by the necessity for resmelting two tons of blue powder for each ton of new ore. So far as I can learn, however, not very much further progress was accomplished during 1912; certainly Trollhattan is not taking ore for which it has contracted

I have been informed that Specketer, Thierry and Johnson have succeeded in avoiding an excessive condensation as blue powder, finding purity of the gas and vapor to be an essential condition, and although I am unable to verify these statements and this conclusion from personal observation and experimentation, both of the latter at McGill University have prepared me to accept their probable truth. I am informed also of some well progressed experimental work wherein the smelting of ore containing 40 to 42% zinc has been done with a power consumption of only 1,175 to 1,200 kw., which in my paper read at Toronto last March I indicated as being a result possible of attainment.

In the United States, W. McA. Johnson, who has been engaged on this problem for seven or eight years, has informed me of the production at Hartford, Conn., of several hundred pounds of spelter per day in campaigns lasting several days, and during 1912 he made perhaps a dozen tons of spelter in the aggregate. The Butte & Superior Copper Co. did some experimentation with the Petersen furnace, with more or less promising results in its own estimation, and toward the end of the year was contemplating a 10-day run at the rate of 2,000 lb. of ore per day. The New Jersey Zinc Co. inaugurated some experimental work in its laboratory at Palmerton, Penn.

In Europe, electrothermic spelter was produced at Trollhattan, to which place I have previously referred. Some tonnage was also produced at Hohenlohehütte, Silesia, by the Imbert Process Co., but reports of what has actually been accomplished there are still conflicting. The Imbert Process Co. has never given out anything about its operations. My private advices from Kattowitz are to the effect that after a great deal of costly experimentation, the process has been practically dropped at Hohenlohehütte. It has also been dropped by the Amalgamated Zinc Co. of Australia, which was looking into it. The Vieille Montagne Company did experimental work with an electric furnace at one of its smelteries. Cote & Pierron also resumed experimental work. This is only a partial list of what has lately been going on.

The history of electric zinc smelting development is thus partaking of the features of the development of other metallurgical process, i.e., the engagement of the interest of many investigators; the conduction of experiment after experiment, many contributing no additional knowledge, some adding a little; and in general the gradual acquisition of knowledge of principles and the art of manipulation, in other words the "learning how." This is inevitably costly and to a large extent is a waste of money, considered narrowly, but regarded broadly the negative results are important along with the others. The outlay in electric zinc smelting investigations has already run into the hundreds of thousands of dollars in several instances whereof I have been informed.

In our own work in Montreal we have heretofore confined ourselves purposely to experimentation upon a small scale in order to determine what might advisably be undertaken on a larger scale, this being considered to be the most economical procedure; and consequently expenditures up to date have been relatively small. I am hopeful that it will prove that we have at last developed a type of furnace upon which we may safely concentrate attention and inaugurate experiments upon a larger scale early in 1913. Our recent work has been pointing that way.

It may be asked, what is in sight as the possible benefit of electric smelting that leads to so much experimentation and so much expenditure of money upon it? A broad answer to this question is that investigation of this subject is directed into one of the great unexplored fields of metallurgy. The rewards, if any, are likely to be of a nature at present unforeseen by anybody. A good deal of the common forecasting of the benefits to be expected from

electric zinc smelting may be dismissed as thoughtless and idle, based upon premises at present unestablished. We cannot at present predict with any certainty that labor and other costs will be materially reduced; they may, or may not. With respect to fuel or power consumption, the two phrases being equivalent, we can see a little more clearly. We can reasonably expect an ability to smelt a ton of zinc ore containing 40 to 42% zinc, with a power consumption of about 1,200 kilowatt-hours. With power costing $10 per horse-power per year, 1,200 kilowatt-hours would cost $1.84; with power at $20 per horse-power per year 1,200 kilowatt-hours would be $3.68. The latter figure does not show any material advantage over the direct combustion of coal. Nor do I see necessarily, or certainly, any higher yield of zinc by the electric furnace than by the ordinary furnace.

On the other hand, there are certain important possibilities of benefit. For example, in the ordinary practice of zinc smelting, the smelters are able to effect an extraction of only about 55 to 60% of the lead content of the ore treated, and about 60% of the precious metals, and such extractions are made only under favorably adjusted conditions and at considerable increase in expense over the cost of smelting for zinc extraction alone. Moreover, there are certain kinds of ore which may not advantageously be treated at all by the present method, such as certain ores that are not amenable to mechanical separation and ores that are high in fluorspar content. In the treatment of such ores, we may find certain distinct advantages in electric smelting, and also, as I have remarked above, we may find advantages in electric smelting that at present we do not suspect at all. Such ideas are, in the main, the justification of the great expenditure in electric zinc smelting investigation that is now being made, both in Europe and America.

Respectfully submitted,

W. R. Ingalls,
Consulting Engineer.

INVESTIGATION OF THE QUARTZ DEPOSITS OF THE KLONDIKE DISTRICT.

During the field season of 1912, Mr. T. A. MacLean was retained by the Mines Branch to undertake an economic investigation of the quartz deposits of the Klondike and adjoining districts in order to obtain a reliable estimate of the probable value of these deposits. Quartz veins in this part of the Yukon are plentiful, though frequently small and non-persistent, and occasionally very encouraging results have been obtained. With rare exceptions, however, it was not known, even approximately, what average amounts of gold the deposits in the different localities contained.

In order, therefore, to determine the average value, together with the most efficient and economical methods of treatment for the various ores, a petition was, early in 1912, presented to the Dominion Government by the Yukon Miners' Association, asking that a testing mill and a thoroughly equipped laboratory be established at Dawson. The quartz to be treated is generally free milling.

Prior, however, to taking any action regarding the establishment of a testing mill, and also in order to obtain a fair general idea as to the gold content of the quartz, it was decided first of all to systematically sample the more important of the known occurrences, and also to endeavour to ascertain their probable lateral and vertical extent. This work was accordingly taken up by Mr. MacLean, and the results of his investigation appear on page 121 of this report.

INVESTIGATION OF METALLURGICAL PROBLEMS OF ECONOMIC IMPORTANCE.

It is generally conceded that the phase of Mines Branch operations which may be described as *original research work,* constitutes one of the most important features of departmental activity. Questions concerning the application of new methods of metallurgical treatment and the discovery of new uses for our minerals themselves are clearly of very real importance to the mining industry of the Dominion.

A single example of the practical results that may be anticipated from such research work is presented in connexion with the conditions which at present govern the marketing of cobalt ores. In the past, the smelters have refused to pay for the cobalt and nickel content, yet it would be surprising if cobalt could not be advantageously utilized in the production of many valuable alloys. It is obvious that other instances of a similar nature might also be cited.

Having in view, therefore, practical considerations of far reaching importance, such as the above, the Mines Branch, in 1910, took steps to further extend the scope of its technical activity. As a result, Dr. H. T. Kalmus was appointed to undertake a series of investigations on behalf of the Mines Branch, at the Research Laboratories of the School of Mining, Kingston. The following investigations may be instanced as exemplifying the character of the work that is being undertaken. An experimental investigation of the metal cobalt and its alloys; a study and report on the present status of the cobalt industry; and an investigation of nickel-copper-cobalt-alloys. Such results as have been obtained up to the present time, are referred to on page 94 of this Summary Report.

PETROLEUM AND NATURAL GAS RESOURCES OF CANADA.

The growing significance of gaseous and liquid hydrocarbons, in their various industrial applications, presents considerations of far reaching importance.

The increasing demand for liquid fuel, whether used under boilers or in internal combustion engines, has of late, constituted one of the outstanding features in power development. Up to the present time, the use of oil as liquid fuel has, in North America, been confined chiefly to the United States. It is estimated that in the United States during 1911, some 62,000,000 barrels of fuel oil were consumed by the railways, the manufacturing interests, and in metallurgical works. During the same period, vessels of the United States navy used 15,000,000 gallons; and it seems probable that, with the continued development of the heavy oil engine, oil fuel for marine service will, within a comparatively few years, be extensively adopted. Already, a large passenger and freight vessel, fitted with internal combustion engines, has on her trial trip, visited the port of New York; and many other vessels similarly equipped are being built, both in Europe and America. Indeed the economic compensations to be gained by the adoption of liquid instead of solid fuel are already such that, in many cases, the higher cost of the former can be afforded. The engineering, and economic advantages presented by the use of liquid fuel are finding a wide expression in various technical journals, and in an extensive bibliography.

During the year 1911, the production in the United States, of natural gas, adapted to a great variety of applications, reached a total of over 500,000,000,000 cubic feet.

Considerations such as the above are of very real interest to the people of Canada; in view of the fact that strong indications exist that this country may also possess gas and oil fields of very considerable value. It has, therefore, been deemed desirable that a report dealing with the petroleum and natural gas resources of Canada should be available for reference. Consequently, during a part of the field season of 1912, Mr. Frederick G. Clapp—assisted by Mr. L. G. Huntley—was engaged, on behalf of the Mines Branch, in the preparation of a report on the petroleum and natural gas resources of the Dominion of Canada. This report will outline the history of developments, status of production, stratigraphy, drilling methods, markets, methods of transportation, quality, utilization, and such other technical details as are necessary in exploiting these resources to best advantage. Such a report is necessary for an operator in one field, who may wish to be informed regarding conditions or methods existing in some other field, and is needed by the layman who may intend entering the petroleum or natural gas business, or associated enterprises, hence requires reliable information regarding conditions or methods in various parts of the Dominion.

DIVISION OF NON-METALLIFEROUS DEPOSITS.

During seven months of the past year, Mr. Fréchette was engaged in collecting data from manufacturers throughout Canada, concerning minerals and mineral products used by them; special attention being given to the quantity, quality, and source of present supply. This investigation was commenced in the previous year, and extended reference to the considerations which prompted it appeared in the Summary Report of the Mines Branch for 1911. Briefly stated, however, the ultimate object of the investigation is to encourage the further use of Canadian minerals, by pointing out to the producers the requirements of the Canadian market, and also the form in which minerals should be prepared, in order to best meet the needs of the various industries in which they are employed.

During the year 1911, the necessary data were secured in the Provinces of Ontario and Quebec. During 1912, the scope of the inquiry was further extended so as to include the remaining provinces of the Dominion.

BITUMINOUS SHALES OF NEW BRUNSWICK.

In the Summary Report of the Mines Branch for 1911, reference was made to the great economic possibilities presented by the development of the bituminous shales of Albert and Westmorland counties, in the Province of New Brunswick. Although the existence, and, to some extent, the possible value of these shales has long been recognized, nevertheless, until quite recently, no serious attempt has been made to develop these deposits.

In 1908, a systematic investigation of the probable extent and economic value of these shales was undertaken by the Department of Mines. The subsequent publication of a complete report, accompanied by a geological and topographical map of the district, did much to direct attention to the important economic aspect of these deposits. It is, therefore, a source of no little satisfaction to learn that the deposits are now in the hands of responsible financial interests, and that active development work has at last been commenced. A letter recently received from Mr. J. E. McAllister, of the operating company, contains the following interesting information:—

Active prospecting work was commenced in July, 1912, and since then has been in continuous progress, with the object of demonstrating the possibilities of quantity and grade of the oil-shale. Living quarters have been constructed for the staff and workingmen, and a fully equipped chemical laboratory installed for the purpose of analysing samples during the progress of the work.

Six diamond drills have been in continuous operation on the property, exploring the strata at depth, and underground openings have been started at eleven different points. In December the total number of men employed was about 140.

Up to the present time, work has been prosecuted in the district lying between the east and west branches of Turtle creek, and also in the neighbourhood of Taylorville, near the Memramcook river. The object of the work is to demonstrate the existence of sufficient oil-shale of commercial grade, to justify the installation of a plant for the distillation of oil, and the manufacture of ammonium sulphate.

OIL AND GAS DEVELOPMENT IN ALBERT AND WESTMORLAND COUNTIES, N.B.

During the calendar year 1912, drilling operations have been actively carried on by the Maritime Oilfields, Limited. A number of new wells have been sunk, although, in certain instances, caving ground has adversely affected the work of drilling. The following tabulated statement is based on information submitted by Mr. O. P. Boggs, Field Manager for the Maritime Oilfields, Limited:—

No. of well.	Total depth.	Total thickness of gas sands.	Total thickness of oil sands.	Flow of gas in cubic feet per day.	Flow of oil.	Rock pressure of gas per square inch.	Location and remarks.
	Ft. In.	Ft. In.	Ft.			Lbs.	
24	1,840 6	16 6	26	1,250,000	Slight show.	702	Stony Creek, Albert co.
25	1,895	12	24	106,000	None.	525	Stony Creek, Albert co.
26	2,323	Not stated.	Not stated	Small.	Slight show.	....	Stony Creek, Albert co.
27	2,645	None.	None.	None.	None.	....	Baltimore Siding, Albert co.
28	1,450	27	38	Not determined.	Slight show.	....	Stony Creek, Albert co.
29	750	....	....	....	....	....	Taylor village, Westmorland co., well temporarily abandoned.
30	1,000	....	....	....	....	....	Near Caanan Station, Westmorland co., drilling still being continued.
31	1,675	Not stated.	7	341,280	....	....	Stony Creek, Albert co.

During the same period, 93,765 gallons (2,679 barrels) of crude oil were produced from the wells at Stony Creek, the whole production being readily disposed of. The expenditure made by the Company in carrying on its operation during the past year, was $83,529.70.

The natural gas has already been piped to the city of Moncton, and to the town of Hillsborough, and is being extensively used in these towns. At present, there are 800 consumers in Moncton and about 130 consumers in Hillsborough. The gas has been installed in several factories in Moncton and Hillsborough, with satisfactory results. The Intercolonial railway of Canada is also using natural gas for power and other purposes, in its large shops at Moncton. Power is developed in two 500 H.P. gas engines and it is said that excellent results are being obtained.

"TAR SAND" DEPOSITS OF NORTHERN ALBERTA.

The history of the Peace and Athabaska country dates back to 1788. During the period that has since elapsed, few travellers, in that part of Canada, have failed to note the presence of extensive deposits of the so-called "'Tar Sands."

As regards what may be termed officially organized exploration in this part of Canada, members of the Geological Survey Branch and of various divisions of the Department of the Interior, have figured prominently. Yet, in considering the numerous references that have from time to time appeared in various departmental publications, it becomes apparent that our knowledge of the real value of these admit-

tedly extensive deposits is practically what it was twenty years ago. And the reason for this is obvious. Parties who have examined these deposits have done so quite independently of each other, and no organized sequence has marked their successive efforts. Consequently, instead of successive reports furnishing new information, there has been a repetition and a reiteration of facts that have long since been established.

In the past, relative geographical remoteness, together with lack of adequate transportation facilities, have effectually prohibited any serious attempt to develop these deposits. The possible early advent of rail transportation, together with the rapid spread of settlement northward, may, however, in a short time, materially modify existing conditions in northern Alberta. With these altered conditions, the active exploitation of the bituminous sands will probably be a matter of only a comparatively short time.

It is generally admitted that the occurrences of native-bitumens, which outcrop along the Athabaska river, are among the largest, if not the largest, in the world. Moreover, analyses of samples of the material, taken casually at a number of points, indicate a content of solid bitumen of from 12 per cent to 18 per cent. But, beyond such uncertain deductions as may be derived from these two statements, we have available practically no information on which to base an intelligent estimate of the real economic value of these deposits. Whether they may more properly be considered as the possible source of various more or less refined products, or whether as a source of supply for paving material, is yet to be determined.

As a demonstrated source of supply for a suitable paving material, the tar sand deposits of northern Alberta would probably at once assume an aspect of real commercial significance throughout a considerable part of northwestern Canada. Modern civilization is intimately dependent on the condition of our highways, and it is unnecessary to here refer to the importance of the benefits to be derived from good roads. Yet one fact should be kept constantly in mind as constituting an outstanding feature in the history of asphalt pavements. This is, that probably 85 per cent of the failures of such pavements may be directly attributed to a misconception of the physical and chemical characteristics of the materials used, and to improper handling and lack of skill in the use of the materials themselves. Thus, in order that the best possible results may be obtained, the physical and chemical characteristics of the bituminous content of the sands must be thoroughly understood. Failure to properly appreciate the importance of these features can only end in unsatisfactory results and in financial loss.

It is, therefore, obvious that, in order to add to the information at present available, regarding the value of these tar sand deposits, such future investigation as may be undertaken must follow a logical programme, embodying consecutively arranged stages. It has, therefore, been deemed advisable that the Mines Branch take such steps as may appear necessary in order to arrive at a correct estimate of the probable economic value of these deposits of northern Alberta. With this end in view, it is proposed that an officer of this Department visit the deposits in question in order to secure such data as may be of value in connexion with their future development.

IRON.

During the field season of 1912, Mr. E. Lindeman made an examination of the iron bearing area in the township of Hutton in the vicinity of Sellwood. This iron range was first located by prospectors during the gold rush in the early nineties, but little interest was taken in its discovery until 1901, when the property was acquired by the Moose Mountain, Limited. In 1906-1907, following a magnetic reconnaissance by C. K. Keith, extensive work of an exploratory nature was undertaken, and facilities for the transhipment of the ore to the Great Lakes were provided by the Canadian Northern railway. In 1909 an attempt was first made to market the crushed crude

product from the No. 1 deposit, but it was found necessary to adopt a simple magnetic cobbing process by which the iron content was raised and a much more uniform product obtained. The total shipments from the No. 1 mine now aggregate approximately 160,000 tons. Owing, however, to the uncertainty of market conditions, the high loss in fines and tailings, and to a desire to utilize the lower grade siliceous deposits, the Company, after considerable experimental work, decided to install the Gröndal process, and in 1911-12, erected a plant with a capacity of about 800 tons crude ore per day. Several innovations have been introduced in the preliminary fine crushing of the ore, and dewatering of the concentrate, and a considerable advance has been made in the briquetting by the introduction of a hydraulic briquetting press.

The enterprising spirit shown by the Moose Mountain Company in erecting a plant for the treatment of the low grade ores of the district is to be highly commended. As pointed out in former reports, Canada possesses notable reserves of low grade iron ores amenable to treatment by magnetic concentration. It is hoped and anticipated that the results attained on a commercial scale at Moose Mountain, will encourage and stimulate the development on a large scale of our extensive but as yet undeveloped magnetite deposits.

During the field season an area of approximately 3 square miles was mapped in detail and the boundaries of eleven ore bodies have been delimited by means of the magnetometric surveys. The ores are associated with a complicated series of highly metamorphosed schists and greenstones, intruded by granite.

COPPER AND PYRITES.

Dr. Alfred W. G. Wilson spent the first six months of the year, with one short interruption, in the preparation of the manuscript of his report on pyrites and its uses. The manuscript of this report was handed to the editor in July; it has since been sent to press, and copies of the printed report will be ready for public distribution early in 1913.

In the latter part of May, Dr. Wilson was instructed to lay aside his other work and proceed to Digby, Nova Scotia, in order to make a special report on an alleged occurrence of coal in that vicinity. He left Ottawa on May 29, and returned to the office on June 7. His report on this investigation is attached to the summary report on his work during the past year.

From July to the end of the year, Dr. Wilson has been occupied in the preparation of his report on the copper resources of Canada. On September 17 he left for the west for the purpose of revising his manuscript in the field. All the copper smelting plants in Canada, and the principal operating mines in British Columbia, were visited during the course of this trip, for the purpose of bringing the report up to date.

After completing his work in British Columbia, he proceeded to San Francisco, to make further inquiries with respect to the Thiogen process for the recovery of sulphur from sulphur dioxide gas. The return trip was made through southern Arizona, for the purpose of visiting some of the larger copper mines and smelting plants in the southwest.

PHOSPHATE AND FELDSPAR.

Mr. Hugh S. de Schmid was, during the field season of 1912, engaged in a further investigation of the phosphate and feldspar deposits of the Dominion. The information thus acquired will be incorporated in a monograph upon these minerals which will be published in due course.

The districts visited included Parry Sound, where a mill has recently been erected for the purpose of grinding feldspar; Frontenac and Lanark counties in Ontario, and the Lièvre phosphate district in the Province of Quebec. The feldspar deposit situated in Manikuagan bay on the lower St. Lawrence was also examined as well as the mica-bearing pegmatites on Pied des Monts and Bergeronnes.

BUILDING AND ORNAMENTAL STONES OF CANADA.

Professor W. A. Parks of the University of Toronto has continued his examination of the building and ornamental stones of Canada. During the field season of 1912, this detailed investigation has been confined to the Province of Quebec. The results of this work will furnish not only descriptions of the different varieties of stone produced in the various localities, but also references to transportation facilities, and other conditions affecting production. There are, in various parts of eastern Canada, a considerable number of quarries which were at one time large shippers, but which, owing to various causes, are at present lying idle. Professor Parks has, therefore, given special attention to a study of those circumstances which have adversely affected the stone working industry.

It is the intention of this Department to include in the present investigation all the provinces of the Dominion, the data so gathered to constitute a monograph on the building and ornamental stones of Canada. It is, moreover, anticipated that this work will prove of special value to builders, contractors, and others, by indicating those localities in which each particular variety of stone may be most readily obtained.

Volume I of this report, including parts I and II, has already been issued, and contains a systematic description of the building and ornamental stones of Ontario. Volume II, which will discuss the building and ornamental stones of the Maritime Provinces, is at present in the press. Copies of this volume should be ready for public distribution not later than May, 1913.

GYPSUM AND SALT.

Mr. L. Heber Cole was, during the first seven months of the year, engaged in the compilation of data previously gathered in connexion with his investigation of the gypsum and salt industries of Canada. Early in August Mr. Cole left Ottawa in order to complete his examination of certain deposits of gypsum in Manitoba and in Nova Scotia. The information obtained during the past two seasons will appear in the form of a revised edition of the monograph on gypsum, issued by the Mines Branch in 1910.

PEAT.

The possible future of peat as an asset of economic value to the Dominion has, for several years, in the laboratory as well as in the field, been the subject of systematic investigation by the Mines Branch. Results of this work have, from time to time, been made public, not only by more or less extended references that have appeared in various Summary Reports, but also in the form of departmental bulletins and reports. The close of 1911, however, marked the successful termination of this experimental work. Thereupon, a company, organized by Mr. J. M. Shuttleworth of Brantford, Ont., petitioned the Federal Government for permission to install at their own cost on the Government peat bog at Alfred a plant in which the partial hand labour of the appliances used in our experimental plant would be replaced by machinery and power. This installation has now been completed, and, as a result, it is anticipated that the production of peat fuel on a commercial scale will be commenced in 1913.

During the field season of 1912, Mr. A. Anrep, Jr., devoted his time wholly to a study of certain of the more important of the peat bogs situated in the Province of Quebec. The report on this work, which will be fully illustrated by maps and diagrams, is now being prepared for the press.

An increased demand for copies of technical publications issued by the Mines Branch, was also noted during the year that has just closed. In 1911, the number of reports and bulletins so distributed was 35,156. In 1912, the number was 40,669, an increase of 5,513 over the previous year.

In addition to the work undertaken by technical officers, the executive work and office routine connected with the administration of the Mines Branch might also be mentioned. During the year the direct correspondence of my own office amounted to 7,528 letters received and 5,454 letters sent out. During the same period the correspondence of the Statistical Division amounted to 1,391 communications received and sent.

I have the honour to be, Sir,

Your obedient servant,

(Signed) **Eugene Haanel,**
Director of Mines.

REPORTS

ON

CHEMICAL LABORATORIES, STATISTICAL DIVISION, ASSAY OFFICE, FUEL TESTING STATION, METALLURGICAL LABORATORIES.

CHEMICAL DIVISION.

F. G. Wait,

Chief Chemist.

The work of the Chemical Division has been along the usual lines, and of the same diversified character, as in former years.

Mr. M. F. Connor, and Mr. H. A. Leverin have devoted themselves with assiduity to the tasks assigned them, and are deserving of our hearty approbation for the amount of excellent work done by them.

The staff was augmented by the appointment, on November 1, of Mr. N. L. Turner, M.A., recently chemist in the Bureau of Mines for Ontario.

During the year 625 samples have been examined, and reported upon. None of these are deserving of special reference here, except one, the discovery, in some cupriferous material submitted to assay, of the presence, in minute quantities, of platinum. The locality of occurrence of the specimens in question, was in the Timiskaming district of Ontario. This occurrence recalls to mind the discovery, in 1889, of sperrylite, an arsenide of platinum, at the Vermilion mine, in Algoma. While it is not improbable that the platinum here alluded to occurs as arsenide, it has not yet been found possible to separate the platiniferous mineral and determine its nature.

The several specimens examined may be conveniently arranged as follows:—

Assays for Gold, Silver and Platinum—During the year 180 samples have been submitted to furnace assay for gold, silver, or platinum. They have been derived from the several provinces and the Yukon Territory, as undermentioned:—

New Brunswick	1 sample.
Quebec	3 samples.
Ontario	43 "
Manitoba	20 "
British Columbia	61 "
Yukon	25 "
Undefined	27 from different provinces.

Fuels—38 samples, comprising lignites, coals, and anthracite coals, from the under mentioned localities in:—

(*a*) Saskatchewan—

Lignites—1. From section 1, south of the town of Unity, seam 42″-48″.

2. From a well 32 feet deep in Block 21 of the town of Kerrobert, seam 18 inches.

3. Sec. 22, Tp. 48, R. 16, west of 2nd meridian.

(*b*) Alberta—

Lignite— 1. S.E ¼ of Sec. 9, Tp. 44, R. 2, west of 4th meridian.
Coal— 2. From a point 2 miles south of Sentinel Siding.
3. From an undefined locality in Kananaskis valley.
4. " " " Peace River district.

(*c*) British Columbia—

Lignite— 1. From a mountain just north of the junction of Bear and Sustut rivers; approximate location 56° 15′ north, and 126° west longitude.
2. Renfrew district, Vancouver island, seam 8 inches.
3. Skonum point, on north shore of Graham island.
Coal— 4. Anthony creek, south fork, in Groundhog coal basin, seam 6 feet.
5. From a point 2 miles northeast of Groundhog summit, seam 3 feet.
6. From the summit of Jackson mountain, seam 3 feet.
7. From the banks of a creek lying immediately north of McDonald creek, seam 9 feet.
8. From Camp Wilson, taken from drift on Sec. 36, or 25 (?) township IX of Graham island.

Anthracitic Coal—
9. From lower tunnel on Discovery creek, Groundhog coal basin.
10. From banks of Klappan river, Groundhog coal basin, seam 9½ feet.
11. From the Skeena river, one sample, from a 7 foot seam, exposed one mile above McEvoys' Camp; and a picked sample taken above the junction of Langlois creek and the Skeena, both in Groundhog coal basin.
12. From McDonald creek, taken from a 6 foot seam, Groundhog coal basin.
13. From Moss creek, just below the mouth of the first creek north of McDonald creek, seam 4 feet.
14. Three samples from seams 'A,' 'B' and 'C,' respectively, in tunnel of the British Pacific Coal Company's workings at Sec. 14, Tp. 2, Graham island.

(*d*) Yukon Territory—

Lignite—
1. Three samples from as many different parts of the old Sourdough seam of the Sourdough mine, in the Coal Creek district.

In addition to the foregoing, analyses, either partial, or proximate, were made upon some eleven samples concerning which no particulars of locality were furnished.

Clays—

During the year, twenty samples of clay have been submitted to analysis, either partial or qualitative, the former with a view to ascertaining whether or not they were well adapted for use in cement manufacture; and the latter as to their suitability for the making of bricks, tiles, or refractory ware.

Copper Ores—

The copper content of twenty copper-bearing ores has been determined. Of these. seventeen were from workings, or claims, in the Sudbury district of Ontario; two

from Shakespeare township, Nipissing district; one from Andersons claim on Manigotagan river—which flows into Lake Winnipeg from the east; and two from British Columbia—one from Alkole creek, south of Revelstoke, and one from Silver Slope creek on the west side of Ottertail valley, near Field.

GYPSUM—

Ten samples of gypsum have been reported upon during the year. Of these, New Brunswick furnished five, and British Columbia five. None were of sufficient special interest as to merit extended reference here.

IRON ORES—

Analyses of twelve iron ores have been made. The samples so examined comprised magnetites, hematites, and limonites, from the undermentioned localities:—

Ontario—

Hastings county—

Magnetite from lot 20, con. XI, of Faraday.
" " 18, " I, of Marmora.
" " 17, " II, of Marmora.

Peterborough county—

Magnetite from lot 19, con. I, of Belmont.
" " 8, " I, "

Alberta—

Two samples of magnetic iron ore, from near Burmis, have been examined. These are of interest, in that they are, not improbably, indurated black sands, formed as an ancient shore concentration. The analyses showed a rather high percentage of titanium, thought to be due to the inclusion in the ore of some titanium mineral, such as sphene or rutile. It is possible that some scheme of separation—magnetic or otherwise—will be adopted which will overcome the objection of the high percentage of titanium.

Iron sands—

Closely related to the foregoing, were 106 partial analyses of concentrates of magnetic iron sands, and of low grade magnetic iron ores, which had been collected by officers of the Department, for treatment at the ore concentration plant of the Mines Branch.

Of these samples, 81 were of magnetic iron sands, and their products at different stages of their concentration—54 of them from Seven Islands, and 27 from Natashkwan, both on the north shore of the lower St. Lawrence. The remaining 22 samples were made up as follows: 3 from Bessemer, and 3 from Childs mine, both in Hastings county, and 8 from Goulais river, Algoma, 8 of so-called Evans' ore, from Carter, W. Va., U.S.A., and 3 from Windy mountain, Alberta.

Later in the year two samples of 'spongy' iron, made at Höganäs in Sweden, by a new process of iron ore reduction, from 'concentrates,' prepared at the ore testing laboratory of this Department, from low grade magnetic iron ore, occurring at Bessemer, Ontario, were analysed.

LIMESTONES AND DOLOMITES AND MARLS—

The analyses of these materials have been done, for the most part, for persons searching for cement-making materials. As the presence of more than 5 per cent of magnesia in a limestone has a prejudicial effect upon its value for this purpose, several of the analyses made were of a partial nature only, merely serving to determine the quantity of deleterious constituents present. Sixty-five samples in all have been examined. Of this number, ten were unaccompanied with any information as to the locality of their occurrence. The remaining fifty-five were from:—

(1) Nova Scotia—
Eskasoni—in Cape Breton county—limestone.

(2) New Brunswick—
Limestone from Rokes' quarry and
" from Purdee and Green's quarry, both at or near the city of St. John.

(3) Quebec—
Soulanges county, from Quinn and Robertson's quarry at Coteau Landing—dolomite.

(4) Ontario—
(*a*) Carleton county—
i. Black river—limestone.
ii. E. ½ of lot 30, con. (?) of Nepean, Ottawa Front, a so-called 'natural cement' stone; an argillaceous, dolomitic limestone. It is said that material from this deposit has been used in the manufacture of cement, employed in the construction of different public works in this city.
(*b*) Northumberland county—
iii. From the water's edge at Presqu'île bay, in Brighton township —a limestone.
(*c*) Ontario county—
iv. From the line of the Trent canal, near Beaverton—limestone.
(*d*) Renfrew county—
v. Limestone from lot (?), con. (?), of Gratton township
(*e*) Victoria county—
vi. Limestone from Lorneville junction, Eldon township.
(*f*) Wentworth county—
vii. Three samples of dolomite from Parks' quarries at Troy, in Beverley township.
(*g*) viii. Limestone, from Bad Vermilion lake, in the Lake of the Woods district.

(5) Alberta—
Dolomitic limestone from 'Mile 88,' G.T.P. railway.

(6) British Columbia—
Four samples of limestone from Popkum, 60 miles north of New Westminster.
Limestone from Sutton formation, from the Duncan quarry, 1 mile west of Raymonds crossing, Shawinigan district, Vancouver island

SANDSTONES—
Twenty-four samples of sandstone from as many different points in New Brunswick and Nova Scotia were collected by Dr. W. A. Parks, in connexion with his forthcoming report on building stones, Vol. II. These were submitted for partial analysis to determine the nature of their binding material, and the percentage of ferrous and ferric oxides in each, these latter having regard to their probable weathering effects.

MISCELLANEOUS EXAMINATIONS—
Certain examinations or analyses done during the year do not properly fall under any of the foregoing headings. In all, twenty-eight different samples were received.
Glass sand from Coleman, Alta.
Supposed mercury bearing sand from Kicking Horse valley at Field, B.C.
Glass sand from Coleman, Alta.

Lubricating oils from the Naval Service Department, examined as to physical properties, viscosity, etc.

Infusorial earth from St. John, N.B., from Cumberland, B.C., and from Prospect lake, Vancouver island.

Tar sand and maltha from Alberta.

Potash bearing rock from Ashcroft, B.C.

Iron ochres.

Crude salt, prepared from brine collected at 'Mile 44,' G. T. P., from Prince Rupert, B.C.

Natural gas.

Supposedly platiniferous clays, from the Porcupine district, Ontario.

Sand from the banks of the Saskatchewan at Saskatoon; and clay from Virden, Manitoba, both thought by the senders to be indicative of petroleum.

Oil-shales.

Coal from Department of Militia and Defence.

MANGANESE ORES—

Two manganese ores, both from Albert county, New Brunswick—one from Gowland Mountain, Elgin parish; and one from Hopewell parish, have been submitted to analysis. Both consisted, essentially, of pyrolusite, with a little manganite.

ORES OF NICKEL AND COBALT—

Twenty-five specimens have been analysed for nickel and cobalt.

By far the greater number of these were from mines now in operation in the Sudbury district, Ontario, and were collected by Dr. A. P. Coleman. Other specimens were taken from unsurveyed territory in the townships of Price and Shakespeare, both in northern Ontario. Five specimens were derived from the banks of Alkole creek, 3 miles from its mouth, south of Revelstoke, British Columbia.

MINERALS AND ROCKS—

Mr. M. F. Connor has devoted his time almost exclusively to the analyses of rocks and minerals collected by members of the staffs of the two branches of the department. Reports have been issued upon 30 samples, and the work upon several others carried on. These results are, however, not sufficiently advanced to be included in this years' summary.

IDENTIFICATION OF SAMPLES—

During the year, one hundred and fifty samples of rocks and minerals were brought, or sent, for identification, and an expression of opinion as to value and uses. These specimens covered a very wide range of material, and were from all parts of the Dominion. The desired information was given in all cases.

REPORT OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

John McLeish.

Chief of Division.

During 1912 the staff of this Division has, as usual, been engaged in the collection of statistics and information respecting the Canadian mining industry, the preparation of annual reports on mineral production, etc., together with the numerous other duties associated with this work.

Statistics of production are collected almost entirely by correspondence and some 2,800 mine and quarry operators now furnish the Department with annual records of their mining or metallurgical output. The method of procedure followed in the collection of statistical information, as well as a description of other functions and duties of the Division have been given in some detail in former summary reports and need not be repeated here. It may, however, be well to explain, that the rapid growth and development of the mining industry, accompanied by a continual increase in the number of producers, involves a constantly increasing amount of work to keep closely in touch with operators.

It has been the practice of the Division, since the collection of these statistics was begun in 1886, to publish a preliminary report on production, subject, of course, to a subsequent final revision, and this has invariably been completed within two months of the close of the year dealt with.

The preliminary report is based largely on actual returns; but, in case of firms from whom returns had not been received until within six weeks of the close of the calendar year, estimates have necessarily been made. Thus, as regards many products, this preliminary report, as now issued, contains a complete record and constitutes a brief but comprehensive review of the mineral industry during the year.

The 'Preliminary Report on the Mineral Production of Canada, during the Calendar year 1911,' was published and distributed on March 6, 1912, and was also included as an appendix to the Summary Report of the Mines Branch for 1911.

The regular work of the Division was somewhat disorganized owing to its transfer to new office quarters. This transfer took place twice during the year, first in May from the Thistle building on Wellington street to the old Geological Survey building on Sussex street which was being specially re-built for the Mines Branch, and again in September to other rooms in the same building.

The publication as advance chapters of separate parts of the final report on mineral production was again continued, and in pursuance of this plan, the following reports were completed on the dates indicated:—

The Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, during the Calendar year 1911—August 10.

A General Summary of the Mineral Production of Canada, during the Calendar year 1911—August 27.

The Production of Iron and Steel in Canada, during the Calendar year 1911—August 28.

The Production of Coal and Coke in Canada, during the Calendar year 1911—October 2.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada, during the Calendar year 1911—October 2.

The complete Report on the Mineral Production of Canada, during the Calendar year 1911, was transmitted for printing on October 16, 1912.

The following lists of operators were revised and reprinted during the year:—

List of manufacturers of clay products in Canada, including a list of the manufacturers of silica or sand-lime brick.

List of lime burners in Canada.

List of stone quarry operators in Canada.

A list of coal mine operators has also been prepared and is now being printed.

Much of the time of the staff is taken up with the preparation of information for correspondents and others respecting the mining industries and mineral resources of the country. During the latter part of the year a special memorandum or report of considerable length was prepared at the request of the Department of Trade and Commerce, for the information of the imperial 'Dominions Royal Commission.' This inquiry covered a broad series of questions on the mining industries and mineral resources of Canada and required considerable time in its preparation.

The routine correspondence of the Division during the year comprised about 1,391 letters sent out and received, in addition to which about 4,281 circular communications were sent out and 2,331 received. Six statistical reports prepared by the Division were distributed during the year, comprising about 13,000 copies.

The annual convention of the Canadian Mining Institute which was held in Toronto, March 6, 7, and 8, was attended by the writer, who presented to the meeting a statistical review of the Canadian mineral production during the previous year.

Mr. C. T. Cartwright devoted the greater part of the year to office work, contributing largely to the preparation of the annual report, with special reference to the chapters on metalliferous production. Much time was also spent in the preparation of field notes and the compilation of material for the forth-coming report on the mining and metallurgical industries of Canada. Mr. Cartwright was engaged in field work in the interests of the Division during November and part of December, and reports in connexion therewith, as follows, viz.:—

'During the month of November, 1912, the writer, in accordance with instructions received, visited parts of eastern Ontario and the Eastern Townships of Quebec, in order to get into closer touch with the mining conditions in those districts.

'Kingston, Belleville, Marmora, Madoc, Deloro, Gilmour, Kaladar Station and other points in eastern Ontario were visited.

'The North American smelter at Kingston was in operation with a plant consisting chiefly of two Scotch hearths, a circular lead blast furnace, hand reverberatory and refining kettle, as well as a bag house for flue dust. This plant was treating Canadian and American lead ores and residues. The Buffalo and Ontario Lead Smelting Company's works on adjoining property was still under construction but was doing a little experimental work.

"At Belleville, Mr. J. W. Evans was continuing experimental work on electric furnace steel production and reported arrangements well under way for work on a commercial scale.

'The Deloro smelter was visited. Both the Cordova mines and the Belmont iron mines at Cordova were doing development work and the Gilmour gold mine near Gilmour Station was also being developed. Work was being done on several of the iron properties of the district.

'Some time was spent in Montreal looking up information with respect to clay and stone industries, and visits were paid to St. Dominique de Bagot and Actonvale, thence to Sherbrooke, near which the Eustis mine at Eustis, the Nichols Chemical Company's acid plant at Capelton, and the East Canada Smelting Company's mine at Weedon, were in active operation.

'Whilst in Montreal an agent for builder's supplies drew attention to the increasing demand for a good quality of common brick suitable for facing purposes and suggested that by the expenditure of a small amount of additional care, on the part of manufacturers, an increased price of probably $2 per thousand might be obtained.

'Acknowledgment is gratefully made of the kindness and courtesy of, and assistance given by all those with whom the writer came in contact.'

A Preliminary Report on the Mineral Production of Canada during 1912, will, as usual, be published about March 1, 1913, and will be included as an appendix to this report.

The total value of the mineral production in 1911 was $103,220,994, or a little less than that of 1910, which was $106,823,623, and the largest recorded up to that time. These outputs, however, have been greatly exceeded in 1912 and an increase of close to 20 [1] per cent may confidently be anticipated.

This large increase in production is not to be ascribed to any particular mineral or group of mines, but has been fairly well distributed among a wide variety of mineral products obtained in Canada, and is indicative of general activity in all branches of the mining industry.

The output in one or two instances was possibly somewhat lessened as a result of strikes among employees, particularly in the case of the operation of coal mines on Vancouver island and in the operation of the Porcupine gold mines during the latter part of the year. Labour difficulties of another kind, viz., a scarcity of suitable labour, were experienced in many of the clay working and quarrying industries, but these difficulties, while sufficiently serious from the industrial point of view, had comparatively little effect on the aggregate mineral output, and the mineral industry may well claim to have had in 1912 the most successful year in its history.

Not only did the output exceed all previous records, but the year has been marked by the extensive development or proving of ore bodies in many mining camps. In the case of the nickel-copper deposits at Sudbury, very large ore bodies indeed have been developed by diamond drilling operations carried on during the past two or three years. Unofficial reports would seem to indicate that these are now the most extensively proved metalliferous ore bodies (excepting possibly iron) in Canada.

In the Cobalt district several important new veins were found, and not a few of the mines have developed new ore reserves in excess of the quantities mined during the year. At least two of the mines at Porcupine have proved the existence of large bodies of gold ore. The copper production of British Columbia has made a new record, and the development of ore bodies in the Rossland district is reported as particularly promising. Ore reserves have apparently also been increased both in the Boundary and Coast districts. The past year has also been marked by many changes and improvements in metallurgical practice. Important changes have been made both at Trail, B.C., and Copper Cliff, Ont., resulting in higher efficiency in production and greater economy of operation. A new smelter has been built at Coniston in the Sudbury nickel district, and an additional smelter is planned as a result of the development carried on by the Dominion Nickel Copper Co.

Not only has there been a substantial increase in the production of the more important metals, but the average prices of most of these metals were considerably higher in 1912 than in 1911. The average price of silver increased from 53·304 cents to 60·835 cents per ounce in 1912, an advance of over 14 per cent. Copper advanced in price from 12·376 cents to 16·341 cents per pound—a betterment of over 31 per cent. The price of zinc increased from 5·758 to 6·943 cents per pound, and lead in the London market advanced from £13·970 per ton to £17·929 per ton. The average price of the same metal in Montreal rose from an average of 3·48 cents in 1911 to 4·467 cents per pound in 1912.

The iron and steel industry, comprising the production of pig iron, steel ingots and rails and other rolled products, was particularly active during 1912, the demand being unusually strong and prices well maintained. Many improvements and extensions are being made or are being projected in iron and steel plants with a view to

[1] The Preliminary Report when completed showed an increase of nearly 30 per cent.

meeting more completely the Canadian demand for these products. That this demand is a large one is evidenced by the fact that, during the twelve months ending March, 1911, there were imported into Canada 1,172,380 tons of iron and steel, valued at $33,838,905, in addition to which manufactures of iron and steel were also imported to the value of $51,480,636. Similar imports of iron and steel during the fiscal year of 1912, amounted to 1,323,348 tons, valued at $37,709,118, together with manufactures of iron and steel valued at $64,859,714.

Notwithstanding the development in the iron and steel industry, the production of iron ore from Canadian sources still remains comparatively small, Canadian blast furnaces being supplied chiefly with imported ore. Developments are in progress however, with a view to the utilization of low grade deposits of iron by means of concentration methods, and already a number of concentrating plants have been constructed.

A wide variety of non-metallic products are obtained in Canada, and the value of the output of these, excluding clay, and stone quarry and associated products, is only a little less than that of ore or metal production. The most important of these in point of value, are coal, asbestos, gypsum, natural gas and petroleum, and salt.

While the asbestos industry has possibly suffered somewhat from over production during two or three years and from over-capitalization in the case of some of the operating companies, these are difficulties which will gradually adjust themselves, and in the meantime the annual sales have been steadily increased.

It will be remembered that the coal mining industry in parts of Alberta and British Columbia in 1910, was practically inactive owing to labour troubles, during a large portion of that year, resulting in a serious falling off in the coal output. The settlement of these difficulties and the re-opening of the mines in November, and their continued operation during 1912, has resulted in a largely increased production, even beyond that of the best previous year.

The development of natural gas resources is worthy of special note. In Ontario, while the production of petroleum is apparently diminishing, the output of natural gas continues to increase. A beginning has been made in the utilization of the gas field at Hillsborough, New Brunswick, gas being now supplied in the city of Moncton whilst further pipe line extensions are proposed.

In Alberta the gas supply from the Medicine Hat field is being utilized to a greater extent each year, while from the field developed at Bow Island gas is now being piped to Lethbridge, Calgary, and numerous other towns in southern Alberta adjacent to the pipe line. Much prospecting for gas is in progress, and, in view of the wide distribution of the gas horizons already developed, it seems not unreasonable to suppose that other important fields will be discovered in this Province.

The year 1912 has been a period of great constructional activity throughout all parts of the country, probably exceeding all previous years, judging by the continued increase in building permits issued in the principal cities. The construction of railways, highways, public works, public and private buildings of all kinds is responsible for a heavy demand for bricks and other clay products, building stone, lime, cement, broken stone, sand, gravel, and other similar products, so that the yearly output of these materials of construction continues to increase at a rapid rate.

Statistical details of mineral production during 1912 are now being compiled, and will be found as already stated, printed as an appendix to this report.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDING DECEMBER 31, 1912.

Dominion of Canada Assay Office,
Vancouver, B.C., January 2, 1913.

Eugene Haanel, Ph. D.,
Director of Mines,
Ottawa, Ont.

Sir,—I have the honour to submit herewith the following particulars in connexion with the operations of the Dominion of Canada Assay Office, Vancouver, B.C., during the year ending December 31, 1912.

The operations of the Assay Office were increased somewhat during the last calendar year, the value of the deposits amounting to $974,077.14, an increase of $326,660.76 over the preceding year.

I understand that the gold output of the Yukon Territory during the past season was approximately $5,000,000, but a very small percentage of the gold was marketed in Vancouver, the source of the bullion deposited at this office being as follows: British Columbia 50,198·24 ounces, value $831,803.20; Yukon Territory 2,211·88 ounces, value $36,480.66; Alaska 6,658·71 ounces, value $105,793.28.

The regulations affecting the rates charged at this office which discriminate in favour of the Royal Mint at Ottawa and the United States Mint at San Francisco, with the consequent marketing of the gold output of the Yukon Territory at these institutions instead of at the Dominion of Canada Assay Office, Vancouver, B.C., have recently been discussed at the meetings of the Vancouver Board of Trade, the Chamber of Mines, the Progress Club, and the Business Men's Club and regrets freely and forcibly expressed in regard to existing conditions. The Mining Committee of the Board of Trade made the following report recently to a General Meeting of the Board which was unanimously adopted.

"We beg to report the following resolution passed by "our Committee":—

"that the ⅛th of 1 per cent assaying and stamping charge made by the local Assay Office be abolished and that franking privileges be given that institution when remitting gold bullion to Ottawa."

"We believe that the Assay Office should be one of the city's most valuable assets, but we feel that the office has not been dealt with to produce the best results both for the city and the government.

"The ⅛th of one per cent above referred to is that much higher cost of stamping and assaying than is made at the Mint at San Francisco and as a great many of the mine operators both in the Yukon Territory and British Columbia are Americans, they naturally prefer to sell their gold in their own country.

"If the assaying and stamping costs were eliminated from the charge at this office, we believe that Vancouver, comparatively contiguous to the Yukon and being the commercial and business centre of British Columbia, would naturally receive a great deal of the gold produced in those districts, and as trade follows the gold, millions of money which now go to the United States would be diverted to our city.

"At the present time, too, our Assay Office sends its gold to Seattle, which seems to us humiliating and hence our suggestion for franking the same to Ottawa.

"By adjusting these conditions so that the charges will be the same as those imposed at the Ottawa and the San Francisco Mints, the benefits accruing in the way of trade and financial prestige would necessarily far outweigh any expense incurred."

A gentleman from the Yukon Territory in the course of an address which he gave at a recent meeting of the Vancouver Business Men's Club, stated that most of the gold of the Yukon Territory passes by Vancouver, despite the fact that it has one of the finest assay offices on the continent. He also said that this flow of gold from the Yukon Territory passed Vancouver's door because there was a discriminating charge of $\frac{1}{8}$th of one per cent imposed at the Assay Office, which was a question of most vital importance, and he urged that the members of the club get together and endeavour to have the discriminating charge annulled. By making the gold come here he declared it would make the people of the Yukon invest their money here. He also showed by reports that even the litttle gold assayed here was sold in Seattle and which had been the case ever since the office was established; he further showed that one and a quarter million dollars worth of gold from the Yukon Territory was sent to Ottawa last year, while that which came to Vancouver was pitifully small although the people of the Yukon liked Vancouver and made it their 'Mecca,' and it was in the interest of this city to welcome them for they would help to build up the city, and said "that in the development of the Yukon we need your help and consequently we want you to buy our gold and we don't want this gold to go to foreign cities."

An individual miner deposited between thirty and forty thousand dollars worth of bullion at this office during the past season, and stated in an interview which he gave to one of the local newspapers that the miners as a rule would prefer to market their gold in Vancouver, and that the flow of gold from the north to this city would make a great difference as miners are heavy spenders and good investors, and as an illustration stated that he had spent upwards of three thousand dollars and would possibly invest over thirty thousand dollars more and that it was the same with every miner, he will do business where he converts his yellow metal into dollars.

The Assay Office was established at Vancouver so that there would be a home market for the output of the gold mines of the Yukon Territory and British Columbia at the most convenient point to where the gold was obtained, it being recognized that the various lines of transportation from the different mining districts centred in Vancouver and that all kinds of supplies could be purchased in Vancouver with the proceeds of the gold sold at the Assay Office, instead of allowing that valuable trade and financial prestige to go to a foreign country, but owing to the regulations affecting the operations of the Assay Office, the results which were anticipated have not been realized.

It is evident that the mine operators desire to market the output of their mines in Vancouver, as gold can be shipped by registered mail from any point in the Yukon Territory and British Columbia to Ottawa or to San Francisco for the same rate as to Vancouver and sold for $\frac{1}{8}$th of one per cent more in either of the two former cities than in Vancouver, but despite these discriminating conditions there were 59,068·83 ounces of gold bullion, of a total value of $974,077.14, deposited at this office during the calendar year just ended.

May I respectfully suggest that the following charges replace those at present imposed on gold bullion deposited at the Dominion of Canada Assay Office, Vancouver, B.C., viz.:—

Charges on bullion 'obtained in Canada,' containing from 100¼ *to* 250 *thousandths, inclusive, of gold and not more than* 100 *thousands base.*

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. Toughening and alloy charge—2 cents per ounce on 1/11th of the standard weight of gold contained in the deposit.
3. Parting and refining charge—1 cent per ounce on the weight after melt; for each additional 50 thousandths base, or fraction thereof, in such bullion one-half cent per ounce shall be added.
4. Assaying and stamping charge—⅛th of one per cent on the gross value of the gold and silver contained in the deposit.

Charges on bullion 'obtained in Canada,' containing from 250¼ *to* 500 *thousandths, inclusive, of gold and not more than* 100 *thousandths base.*

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. Toughening and alloy charge—2 cents per ounce on 1/11 of the standard weight of gold contained in the deposit.
3. Parting and refining charge—2 cents per ounce on the weight after melt; for each additional 50 thousandths base, or fraction thereof, in such bullion one-half cent per ounce shall be added.
4. Assaying and stamping charge—⅛th of one per cent on the gross value of the gold and silver contained in the deposit.

Charges on bullion "obtained in Canada," containing from 950 *to* 991¾ *thousandths, inclusive, of gold and not more than* 30 *thousandths base.*

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. Toughening and alloy charge—2 cents per ounce on 1/11th of the standard weight of gold contained in the deposit.
3. Parting and refining charge—3 cents per ounce on the weight after melt.

Charges on bullion 'obtained in Canada,' containing 992 *thousandths of gold and upwards.*

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. An assaying and stamping charge of ⅛th of one per cent of total value of bar.
3. An alloy charge of 2 cents per ounce of copper required to make into coin.
4. A charge of ¼ to 2 cents per gross ounce on brittle bars, the adjustment of this charge depending on the difficulty of rendering the bar ductile to be left to the manager of the Assay Office.
5. No allowance shall be made to the depositor for silver.

Charges on bullion 'obtained in Canada,' containing from 500¼ *to* 949¾ *thousandths, inclusive, of gold.*

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. Toughening and alloy charge—2 cents per ounce on 1/11th of the standard weight of gold contained in the deposit.
3. Parting and refining charge—4 cents per ounce on the weight after melt.

Charges on dental and jewellers' waste and old jewellery.

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.
2. Toughening and alloy charge—2 cents per ounce on 1/11th of the standard weight of gold contained in the deposit.
3. Parting and refining charge—4 cents per ounce on the weight after melt.
4. Assaying and stamping charge—⅛th of one per cent on the gross value of the gold and silver contained in the deposit.
5. An additional charge shall be imposed equal to the cost of fuel, labour, and material when remelting and special treatment of the bullion is necessary.

Charges on bullion "from foreign countries" deposited at the Dominion of Canada Assay Office, Vancouver, B.C.

1. Melting charge—$1 on each melt of 1,000 troy ounces or fraction thereof.

2. Toughening and alloy charge—2 cents per ounce on 1/11th of the standard weight of gold contained in the deposit.

3. Parting and refining charge—4 cents per ounce on the weight after melt.

4. Assaying and stamping charge—⅛th of one per cent on the gross value of the gold and silver contained in the deposit.

5. An additional charge shall be imposed equal to the cost of fuel, labour, and material when remelting and special treatment of the bullion is necessary.

May I further suggest that franking privileges be granted to this office to ship gold bullion by registered mail to Ottawa and that all bullion purchased at this office be shipped by registered mail to the Royal Mint at Ottawa and insured whilst in transit, the rate of insurance on gold bullion by registered mail Vancouver to Ottawa being thirty-five cents per thousand dollars value; also that the bars or units of shipments from this office may weigh 1,000 troy ounces (I am informed that parcels or sacks of bullion by registered mail from Dawson to Ottawa and to San Francisco frequently weigh as much as 200 pounds avoirdupois, or about 3,000 troy ounces), which would save a vast amount of expense and at the same time reduce the risk in transit to a minimum as compared with shipments made up of smaller bars.

DETAILED STATEMENT.

There were 527 deposits of gold bullion, requiring 597 melts and 597 assays (quadruplicate check assays being made in each instance), including the assembling and remelting of the individual deposits after purchase into bars weighing about 1,000 troy ounces each, and the assaying of same. The aggregate weight of the deposits before melting was 59,068·83 troy ounces and after melting 58,029·72 troy ounces, showing a loss in melting of 1·7592 per cent. The loss in weight by assaying was 5·77 troy ounces (base and parted silver), the average fineness of the resulting bullion, viz., 58,023·95 troy ounces, being 0·810¾ gold and 0·055½. The net value of the gold and silver contained in deposits was $974,077.14.

The gold bullion received came from the following sources, viz.:—

Source.	Number of deposits.	Weight.		Net value.
		Before melting.	After melting.	
		(Troy ounces.)	(Troy ounces.)	$ cts.
British Columbia	436	50,198·24	49,292·34	831,803 20
Yukon Territory	63	2,211·88	2,143·46	36,480 66
Alaska	28	6,658·71	6,593·92	105,793 28
	527	59,068·83	58,029·72	974,077 14

Weight before melting	59,068·83	troy ounces.
Weight after melting	58,029·72	"
Loss by melting	=1,039·11	"
Loss percentage by melting	1·7592 %	

Credits and Disbursements for the Purchase of Gold Bullion During the Year Ending December 31, 1912.

Unexpended balance, "Letter of Credit," January 1, 1912.......		$ 28,985 02
Credits established during year ending December 31, 1912........		1,100,000 00
"Letter of Credit" balance written off at close of fiscal year, March 31, 1912	$ 54,791 28	
Disbursements for the purchase of bullion........	974,077 14	
Unexpended balance, "Letter of Credit," December 31, 1912......	100,116 60	
	$1,128,985 02	$1,128,985 02

Disbursements for the Purchase of Gold Bullion and Receipts from Sale of Same During the Year Ending December 31, 1912.

Disbursements for the purchase of bullion on hand, January 1, 1912, bars Nos. 346, 347, 350 to 381 inclusive........		$ 13,591 37
Disbursements for the purchase of bullion during year ending December 31, 1912—Cheques Nos. 382 to 438 inclusive (less No. 427 cancelled), and Nos. 1 to 472 inclusive (less No. 74 cancelled)		974,077 14
Proceeds from sale of bullion during year ending December 31, 1912	954,438 94	
Value of bullion on hand, December 31, 1912, bars Nos. 461 to 472 inclusive	33,897 13	
Difference in favour of this office........		667 56
	$988,336 07	$988,336 07

Contingent Account for Year Ending December 31, 1912.

Unexpended balance, January 1, 1912........		$ 53 38
Funds provided per official cheques Nos. 990, 1104, 1209, 11, 93, 287, 398, 498, 612, 720, 868, and 1023........		2,160 00
Amount remitted Receiver General, per draft No. 273, at close of fiscal year, March 31, 1912........	$ 13 06	
Expenditure during year ending December 31, 1912........	2,199 92	
Unexpended balance, December 31, 1912	40	
	$2,213 38	$2,213 38

Contingent Expenditure During Year Ending December 31, 1912.

Fuel (gas)	$ 312 60
Power	175 03
Express charges on bullion	755 95
Express charges on stationery from Ottawa	10 50
Electric vault protection service	300 00
Postage	20 00
Telephones	75 00
Assayers' and melter's supplies (purchased locally)........	322 11
Typewriter ($150, less $15 allowed for old machine)........	135 00
Sundries	93 73
	$2,199 92

Proceeds from Residues Sold March, 1912.

Residue sold to United States Assay Office, Seattle, Wash., U.S.A. (bar No. A-6).	$398 96
Thirty empty acid bottles sold to B.C. Assay & Chemical Supply Co., Ltd., Vancouver, B.C........	4 50
	$403 46

Residues on Hand, December 31, 1912.

Recovered from slag, sweepings, old furnaces, old crucibles, etc., 28·75 ounces, value	$408 79
Twenty-eight empty acid bottles.	

Miscellaneous Receipts.

Draft No. 262, in favour of Deputy Minister of Mines (a payment for four special assays)	10 00
Draft No. 265, in favour of Deputy Minister of Mines (a payment for one special assay)	2 50
Draft No. 292, in favour of Deputy Minister of Mines (a payment for melting 119·55 ounces silver bullion)	5 00
Draft No. 300, in favour of Deputy Minister of Mines (a payment for melting 0·25 ounces bullion, $1; and one special assay, $2.50)	3 50
Draft No. 309, in favour of Deputy Minister of Mines (a payment for treating 27 lbs. slag)	12 00
	$33 00

The following shows the business done by the Assay Office since its establishment:—

Year.	Number of deposits.	Weight.	Net value.
		(Troy ounces.)	$ cts
1901–2 (fiscal)	671	69,925·67	1,153,014 50
1902–3 "	509	36,295·69	568,888 19
1903–4 "	381	24,516·36	385,152 00
1904–5 "	443	29,573·73	462,939 75
1905–6 "	345	21,050·83	337,820 59
1906–7 (9 months)	269	20,695·84	336,675 65
1907–8 (fiscal)	482	46,540·25	751,693 97
1908 (9 months)	590	90,175·48	1,478,893 74
1909 (calendar)	573	48,478·60	789,267 94
1910 "	490	46,064·31	746,101 92
1911 "	442	39,784·70	647,416 38
1912 "	527	59,068·83	974,077 14

(Signed) G Middleton,

Manager.

G. MIDDLETON, Esq., December 31, 1912.
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

SIR,—I beg to inform you that we have the following assayers' supplies on hand, viz.:—

Silver nitrate crystals	1 oz.
Calcic chloride	1 lb.
Lead foil, C.P.	100 lbs.
" granulated, C.P.	3 "
Zinc, mossy, C.P.	$\frac{3}{4}$ lb.
Litharge	5 lbs.
Copper wire	$\frac{1}{2}$ spool.
Argols	2 lbs.
Nitric acid	2 Winchesters.
Hydrochloric acid	$\frac{3}{4}$ "
Ammonia	$\frac{1}{2}$ "
Small clay crucibles	8 only.
Scorifiers, 4″	3
" 2¼″	1
Spare muffles	25
" " doors	4
" " supports	8
" " back stops	14
" " plugs	17
Morganite	10 lbs.
Bone ash	25 "
Fireclay	20 "
Cupels	3,000
Gold cornets	6·46 ozs.
" proof	8·06 "
Silver	76·3 "

Your obedient servant,

(Signed) **J. B. Farquhar,**
Chief Assayer.

G. MIDDLETON, Esq., December 31, 1912.
Manager, Dominion of Canada Assay Office,
Vancouver, B.C.

SIR,—I beg to inform you that we have the following supplies on hand in the Melting Department, viz.:—

2 sets of linings, with supports and covers complete, for No. 1 furnace.
2 " " " " " No. 2 "
2 " " " " " No. 4½ "
2 " " " " " No. 7 "
9 Graphite crucibles, No. 6.
2 " " No. 10.
48 " " No. 16.
6 " " No. 30.
20 " " No. 40.
43 " " marked ⁰₀⁰₀
2 Crucible covers, No. 14.
2 " " No. 30.
2 Graphite stirrers.
5 lbs. pot. nitrate.
75 lbs. carb. soda.
110 lbs. borax glass.

Your obedient servant,

(Signed) **D. Robinson,**
Chief Melter.

ACCOUNTANT'S STATEMENT.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office between April 1, 1911 and March 31, 1912.

Paid for bullion at Dominion of Canada Assay Office, Vancouver.	$645,208 72
Received for bars from United States Assay Office, Seattle........	645,620 10
Difference in favour of Dominion of Canada Assay Office..........	$411 38

STATEMENT OF DEPOSITS OF GOLD AND EARNINGS.

Deposits of gold	$645,620 10
Earnings—	
Treating 60 lbs. of slag for John Hopp........................	$ 27 50
Special analysis for S. Henderson..............................	10 00
Special assay for A. Wilson	2 50
Value of residue sold United States Assay Office..................	398 96
" 30 empty bottles sold British Columbia Assay and Chemical Supply Co..............................	4 50
	$443 46
Difference between amounts paid and received for bullion........	411 38
	$854 84

The following is a statement of appropriation, receipts, and expenditure of the Dominion of Canada Assay Office for the year ending March 31, 1912, and shows the unexpended balance to be $5,461.59.

	Appropriation.	Expenditure.
Appropriation, 1911-12..................	$17,000 00	
Receipts per the foregoing statement.................	443 46	
Difference between amounts paid and received for bullion	411 38	
Fuel		$261 95
Power and light		152 87
Postages and telegrams		40 34
Telephone		60 50
Express charges		534 43
Assayers' supplies		287 40
Printing and stationery		59 69
Premium on bonds		570 00
Contingencies		72 64
Electric burglar alarm service		300 00
Wages—		
G. Middleton		2,650 00
J. B. Farquhar		1,900 00
D. Robinson		1,562 30
A. Kaye		1,466 13
G. N. Ford		1,500 00
G. B. Palmer......................		975 00
Balance unexpended		5,461 59
	$17,854 84	$17,854 84

(Signed) Jno. Marshall,
Accountant.

I.

FUELS AND FUEL TESTING DIVISION.

B. F. Haanel,

Chief of Division.

The personnel of this division has remained unchanged during the year. The most important addition made to the equipment of the fuel testing station has been the installation of a No. 6, Type A, rotary station meter, supplied by the Rotary Meter Co., of New York. This meter has a capacity ranging from 1,500 to 15,000 cubic feet of gas per hour. An antipulsator has also been purchased; and will be installed between the meter and the gas engine. This will overcome the pulsations in the gas main caused by the intermittent suction of the gas engine, and thus enable the meter to record correctly the volume of gas passing to the engine. With this new equipment, it will be possible to carry out a producer test with or without the gas engine. The new 100 H.P. Westinghouse producer can, therefore, now be operated to its full capacity, instead of only to the capacity of the 60 H.P. engine.

During the earlier part of the year, the Körting peat gas producer plant was run frequently, in order to supply power for the ore concentrating laboratory; and also to permit of experiments being conducted in connexion with the by-product tar derived from the peat.

During the month of June trial runs were carried out with the Westinghouse producer using a lignite supplied by the Consumers Coal Co., of Moosejaw, Sask. A copy of the report on these trials is subjoined herewith. Peat from the government bog at Alfred, also gave most successful results when used in the Westinghouse producer. During the latter part of the year the experimental work at the fuel testing station was suspended on account of alterations and additions being made to the building.

These additions to the building were primarily intended to provide suitable accommodation for the work of the Ore Dressing and Metallurgical Division; but advantage was taken of this extension, to provide at the same time, the extra accommodation which was urgently needed for carrying on the work of the Fuel Testing Division. The eight rooms provided in the new extension are apportioned as follows: (1) gas analysis and calorimetry room; (2) chemical stores; (3) balance room and chemist's office; (4) general laboratory; (5) furnace room for gas and electric furnaces for analytical and research purposes; (6) sampling room; (7) machine stores; (8) machine workshop. The raising of the roof over a part of the old building, has provided a large new room to be used as a joint office and draughting room for both Divisions. The room previously used as an ore dressing laboratory is now available for use as a boiler room and it is proposed to install in it shortly, for experimental purposes, a boiler of about 70 H.P. capacity. With this additional equipment it will then be possible to determine the commercial value of any coal when used either under a steam boiler or in a gas producer.

The electric installation for the station has also been remodelled. Three large transformer cells have been installed, and a new and considerably enlarged switchboard has been designed. This will control the high voltage current supplied to the transformers and will also supply alternating or direct current as required at any points throughout the building. In addition to the necessary commercial type of indicating instruments, the switchboard will also carry a set of precision instruments for testing purposes.

Advantage has, at the same time, been taken of the temporary cessation of testing work, to rearrange some of the auxiliary apparatus in order to reduce the number of small motors employed. The heating system for the building has also been augmented and improved.

During the summer Mr. J. G. S. Hudson visited the productive coal areas of Alberta and Saskatchewan, and shipped to the fuel testing station five samples of lignite—each twenty tons or over—to be tested in the Westinghouse producer. It had been proposed to test these samples immediately they were received, but the unavoidable derangement of the plant, during the building of the extension, rendered this impossible. The samples have, therefore, been carefully stored in a dry shed, and it is hoped that their fuel value will be thoroughly investigated during the spring of 1913. In a report, subjoined herewith, Mr. Hudson briefly outlines the result of his investigation in Alberta and Saskatchewan.

The work of the chemical laboratory has been continued along similar lines to those followed in previous years; the report of the chemist is subjoined herewith.

During the year Mr. Anrep investigated certain of the more important peat bogs in the Province of Quebec and his interim report is also subjoined herewith. Mr. Anrep is at present engaged in preparing for the press a complete report dealing with his investigations of peat bogs in the Provinces of Quebec, Ontario, and Manitoba. This report will be fully illustrated with maps and photographs.

The Fuels and Fuel Testing Division is being consulted more and more by those who desire expert advice on matters connected with the utilization of fuels, for purposes of power production. During the year active steps have been taken in order that this Division should be kept thoroughly in touch with the present status of power production in Canada and elsewhere. Towards the latter part of July a circular letter was sent to the operators of a number of gas producer plants throughout Canada, requesting information relative to cost of production, ease of operation, etc. Hearty thanks are due to the different gentlemen who, in their replies, took great pains to furnish all such information as might prove of value. During July and August the writer personally investigated the status of gas power production in western Canada, and the results of observations made and data collected during this trip will be set forth in the form of a separate bulletin. In December, accompanied by Mr. Blizard, he left for Europe for the purpose of investigating peat and other power gas producers, both of the non-recovery and of the by-product recovery types. A fully illustrated report will be published during the coming year, describing the results of this investigation.

An account of the tests, conducted with the Körting peat gas producer at the fuel testing station, was published during the past year. This report (Mines Branch No. 154) is entitled "The Utilization of Peat Fuel for the Production of Power," and comprises a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910-11. During the past year the writer has in addition also presented scientific papers at the annual meeting of the American Peat Society, and before the Eighth International Congress of Applied Chemistry, held in New York city.

II.

REPORT ON A TEST OF LIGNITE COAL FROM THE CONSUMERS COAL COMPANY, MOOSEJAW, SASK.

OBJECT OF TEST.

The object of this test was:—

(1) To observe the behaviour of the lignite when burned in a gas producer.

(2) To determine the method of operation which would produce the most effective results.

(3) To determine the calorific value per cubic foot of the gas, and the volume of gas in cubic feet produced per ton of lignite gasified.

DESCRIPTION OF TEST.

Before commencing the test, a proximate analysis of the lignite was made, and its calorific power and moisture determined. The lignite was then burned in the Westinghouse double zone bituminous gas producer.

The producer was first built up with Pittsburgh bituminous slack coal, with which the staff of the Fuel Division had previous knowledge and experience; when this was partly run through, the producer was fed with lignite. For the purpose of ascertaining the efficiency of any fuel in a producer of this type and capacity (125 H.P.), and the volume of gas produced per ton of fuel, it is necessary, first, that the producer contain no other fuel than the sample to be tested at the time the test is commenced, and, second, that the test be continuous and of sufficient duration to ensure that the condition and the amount of the fuel in the producer at the end of the run are the same as at the beginning, and such a test is generally of sixty or more hours' duration.

The following points were observed:—

(1) The behaviour of the fuel in the producer.
(2) The most efficient method of operation.
(3) The suitability of the gas generated for burning in the gas engine.

PROXIMATE ANALYSIS OF THE LIGNITE BY FAST COKING.

1. Moisture..	32·42	per cent.
2. Volatile combustible matter..	28·29	"
3. Fixed carbon..	31·32	"
4. Ash..	7·97	"
	100·00	"
Coke..	39·29	"

Fuel ratio, 1:1·10.

Calorific value of moisture free fuel, 10,000 B.T.U. per lb.

Average effective calorific value of gas per cub. ft., 115 B.T.U.

CONCLUSIONS.

(1) The lignite can be fed into the producer in the condition it is unloaded from the car, it being unnecessary to submit it to crushing. The larger pieces are broken, when necessary, by a sledge.

(2) The fuel burned uniformly without the formation of troublesome clinkers, and when the attendant had acquired the method of operation, but little attention, other than feeding the fuel and poking the fires of the two zones twice a day, was required.

(3) The gas generated was tar free, and the heating value was satisfactory.

(4) The engine was operated at a load of 50 brake horse-power for about forty hours, and when examined at the termination of the run, the valves were found to be exceedingly clean.

(5) As a result of this test, this lignite may be pronounced as an excellent fuel for the production of power, when utilized in a producer gas power plant, the fuel as it arrives from the mine requiring no further treatment, such as crushing. The tendency, moreover, of the lignite to disintegrate into small fragments, on exposure to the air, does not in any way interfere with its operation when burned in the gas producer.

The volume of gas generated per ton of lignite, and the thermal efficiency, were not determined. The indications, however, are that this would have been satisfactory if the test could have been run for sixty hours.

III.

SAMPLING OF LIGNITIC AND SEMI-BITUMINOUS COALS OF ALBERTA, FOR GAS PRODUCER TESTS.

J. G. S. Hudson.

The present rapid increase of population, emphasizes the growing importance of the fuel problem in the Provinces of Manitoba, Saskatchewan, and Alberta. In certain parts of these prairie provinces, but especially in the Province of Alberta, extensive deposits of coal are known to exist, and are being actively developed at many points. In their classification, these coals range from the lower grade lignites to semi-anthracites.

In their economical utilization for power development purposes, the physical and chemical characteristics of these lignitic coals present certain difficulties. The question of how they may best be utilized, thus becomes of very real importance to the people of western Canada, and has for some time past been the subject of serious consideration by the Mines Branch of the Department of Mines.

During the past three years, the Fuels and Fuel Testing Division of the Mines Branch has carefully studied the possibilities of certain types of gas producers and gas engines, in connexion with the economic utilization of peat and other fuels. In the light of this practical investigation, it is now felt that the fuel problem of Alberta may, in part, be solved by the introduction of the gas producer. In order, therefore, to determine in a practical manner the extent to which this may be the case, it was decided to secure a number of commercial samples of coal, that would be representative of the various classes of lignites now being mined in Alberta.

On June 19, 1912, the writer was instructed to secure the samples required. The scope of the work entrusted to him will be seen from the following letter of instructions.

OTTAWA, June 19, 1912.

SIR,—You are herewith instructed to proceed to the Provinces of Alberta, Saskatchewan, and Manitoba, and obtain samples of lignite coal from producing mines in the above-named provinces, for coal tests to be made at the Dominion Government Fuel Testing Station at Ottawa. The following salient points must be observed, namely:—

The quantity of coal required for a commercial test must be twenty tons.

This coal must be forwarded to Ottawa by the quickest possible freight; and must be shipped either in bags suitable for the purpose, or in a covered box car having sufficient bulkheads, so that it will reach its destination in good condition.

LABORATORY SAMPLES OF COAL.

These samples of coal require to be obtained from several districts of the mine, representative of the full section of the coal seam, and quartered down to ten pounds in weight. They are then to be placed in air-tight canisters or jars, distinctly marked with the name of the mine; name of the coal seam worked; location from which the sample was obtained and a section of the coal seam by measurement, giving character of the roof and pavement, and impurities contained in the bands of shale which may intersect the seam of coal.

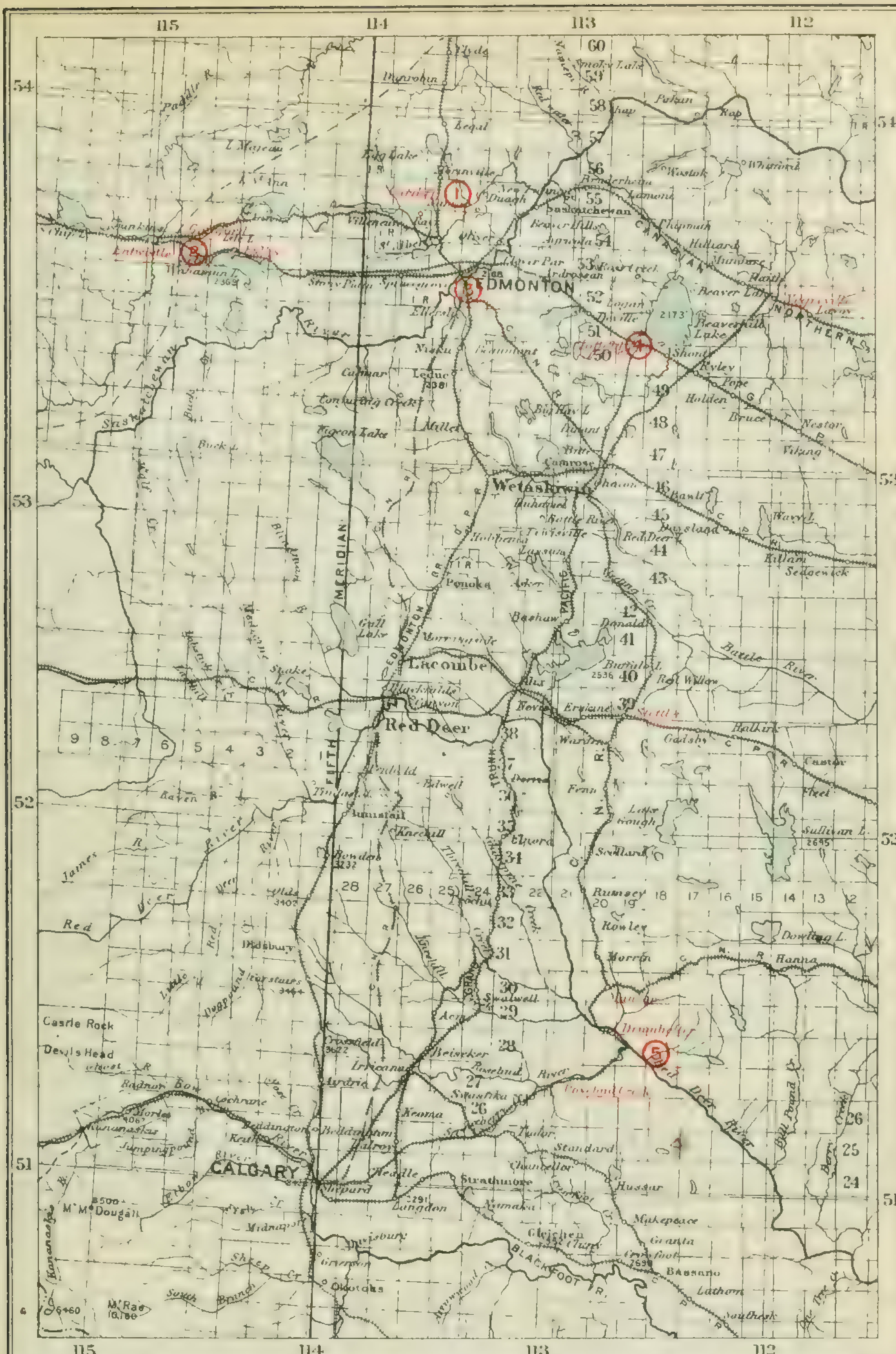
Whenever possible, procure tracings of the mine plan, and indicate thereon the exact position in the mine from which the sample was taken.

You are also instructed to take notes of each mine from which samples of coal are obtained, giving full information thereon, as indicated in the field book submitted for my approval.

(1) On the large scale maps of Alberta, Saskatchewan, and Manitoba; designate all the producing coal mines, marking distinctly bituminous and lignite classifications.

(2) Estimate tonnage of coal areas according to commercial centres.

(3) Representative coal mines, according to consumption and population of commercial centres.



Base map Dept of Interior

PROVINCE OF ALBERTA

Showing properties from which samples of Coal were taken for Gas Producer Tests, Fuel Testing Division, Ottawa

SCALE 35 MILES TO 1 INCH

25 0 25 50 75

1. Cardiff Collieries
2. Gainford Collieries, Ltd.
3. Twin City Mine
4. Tofield Coal Co.
5. Rosedale Coal and Clay Product Co.

Samples secured by J.G.S. Hudson

(4) Specific mines from which samples are to be taken, having in view railway transportation facilities, situation defined according to population of cities and towns, for production of power.

INFORMATION REQUIRED.

(1) Consumption of coal for power purposes in the commercial centres.
(2) Transportation, mileage, and freight rates.
(3) Power plants installed, consumption of coal, price of coal delivered at commercial centres, cost of producing horse-power, and horse-power used.
(4) Obtain data of quantities of natural gas used, cost per 1,000 cubic feet delivered for commercial and domestic use, cost of installation, drilling, pipe lines, and maintenance.
(5) Producer gas; give description of plants, cost of installation, and prices paid by consumer per horse-power.

(Signed) **Eugene Haanel,**
Director of Mines.

Mr. J. G. S. Hudson,
Mines Branch, Ottawa.

As a preliminary step, prior to the securing and shipping of these samples, officials of the principal railway companies in Canada were approached with a view to securing their co-operation, particularly in the matter of granting special freight rates on car load lots of coal. On learning of the object of the investigation, and of the manner in which it was to be undertaken, the administrative heads of the Canadian Pacific railway, Grand Trunk railway, Grand Trunk Pacific, and Canadian Northern railway expressed their appreciation of the practical value that should attach to the results of such work, and promised their hearty co-operation. The question of special freight rates was subsequently placed before the members of the Tariff Bureau at Winnipeg, with the result that such rates were granted on car load samples of coal when consigned to the Fuel Testing Station of the Mines Branch.

In carrying out the instructions received, the writer first proceeded to Calgary in order to lay before the principal coal operators there, the purpose and scope of the work of the Fuel Testing Division of the Mines Branch. On this, as well as on subsequent similar occasions, the most hearty co-operation was promised in connexion with the proposed investigation. Indeed, coal operators without exception, expressed their perfact willingness to furnish this Department, free of charge, such twenty ton samples of coal as might be required.

On July 24, Edmonton was reached, and the object of the work of the Mines Branch placed before Mr. John Stirling, Chief Inspector of Mines for the Province of Alberta. Mr. Stirling, on behalf of the Provincial Mines Department, very kindly expressed his entire willingness to co-operate with the Mines Branch in any way that might be possible.

After a careful study of conditions affecting the production and marketing of coal within a radius of 50 miles of Edmonton, four mines were selected from which twenty ton samples should be taken for the proposed gas producer tests. The properties thus chosen were those of the Twin City Coal Co., Ltd., the Cardiff Collieries, Ltd., the Tofield Coal Co., Ltd., and Gainford Collieries, Ltd.

Twin City Mine.

This colliery is located on the Strathcona side of the Saskatchewan river, and is within the limits of the city of Edmonton. The operating company is incorporated under the name of the Twin City Coal Company, and the head office is in Toronto. The area controlled by the Company comprises 367·5 acres, and the estimated gross tonnage of coal is placed at 1,500,000 tons. The coal mined is lignite.

The colliery is served by a branch line of the Edmonton, Yukon, and Pacific railway, operated by the Canadian Northern Railway Company. It also has rail connexions for shipments over the Canadian Pacific railway, Grand Trunk Pacific and Canadian Northern Railway systems.

The following section was measured at the face of number six entry south, on July 31, 1912, and represents a fair average section.

Roof, good hard grey shale.

	Ft.	In.
Coal	2	2
Clay	0	6
Coal	3	2
Total	5	10

The pavement consists of hard fireclay.

The surface equipment consists of a bank head and screens built of wood, and so arranged that the coal can either be screened and delivered into railway cars for rail shipment, or diverted to a series of storage bins, arranged to deliver the coal into carts for the local and domestic trade. The screens used are of the fixed bar type, being 14 feet long, 6 feet wide, and with 1¾″ openings between the bars. They have been so arranged as to make the several grades of coal required for commercial and domestic uses.

The mechanical installation comprises hoisting engine, boilers, air compressor plant for supplying power to the coal cutting machines, and adequate ventilating equipment. There are also the necessary machine, carpenter, and blacksmith shops.

The seam of coal that is being worked is known as the "Clover Bar," and was reached at a depth of 203 feet in the main hoisting shaft. The following section was measured in the sixth entry south.

Roof, shale, fine grained, greyish brown in colour, character good.

	Ft.	In.
Coal, good	2	2
Clay, band	0	6
Coal, good	3	2
Total	5	10

Pavement, underclay, soft when exposed to the air.

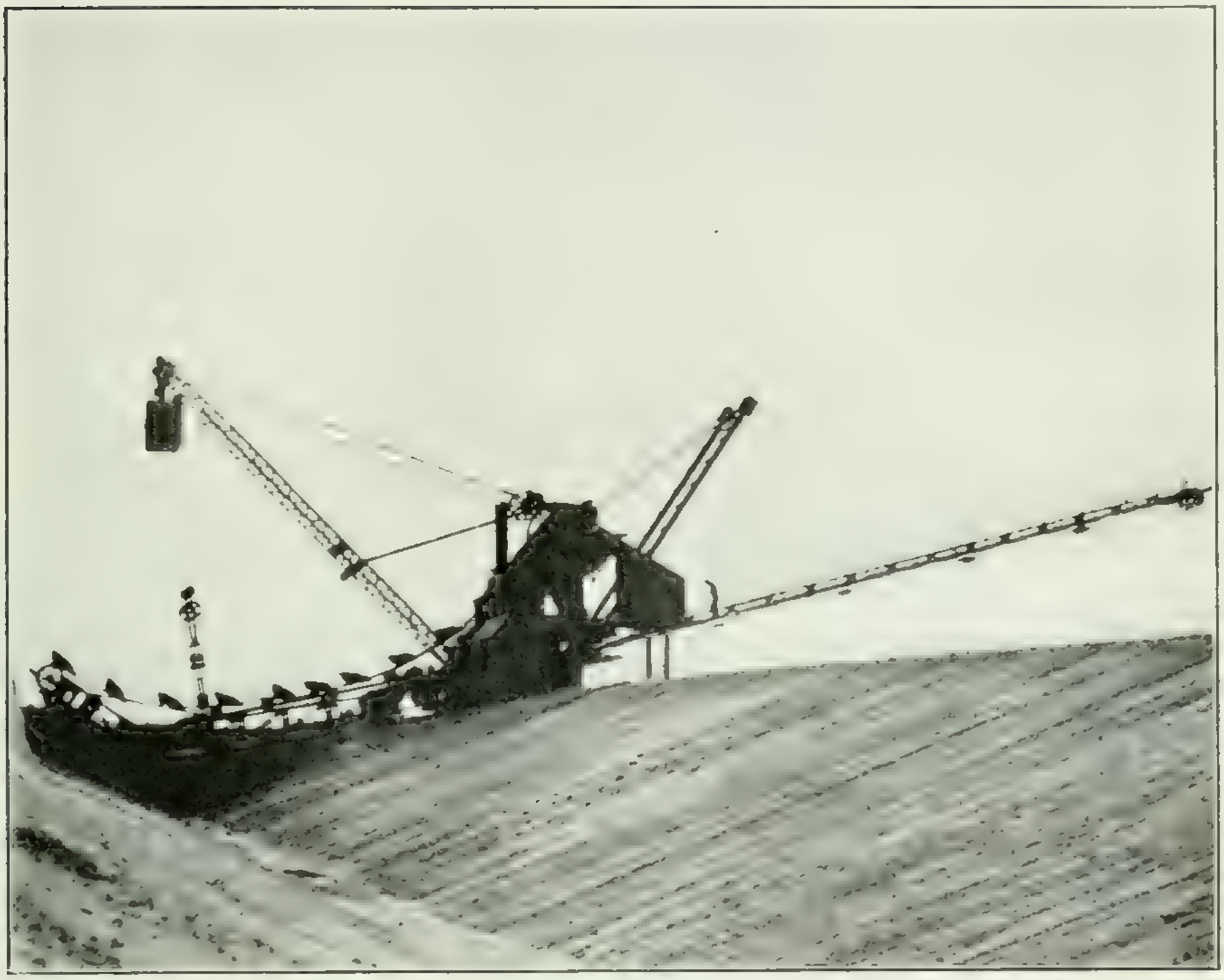
In working the coal, the bord and pillar system has been adopted. Main levels or entries are driven from which the rooms are turned off, driven up for a distance of 200 feet, then stoped, and the pillars extracted. Main levels are driven 10 feet in width, rooms 16 to 18 feet in width, and pillars of corresponding thickness.

The coal cutting machines in use are of the radial type, and are manufactured by the Rand Company of Sherbrooke, Quebec. If required, the present output of this mine could be substantially increased.

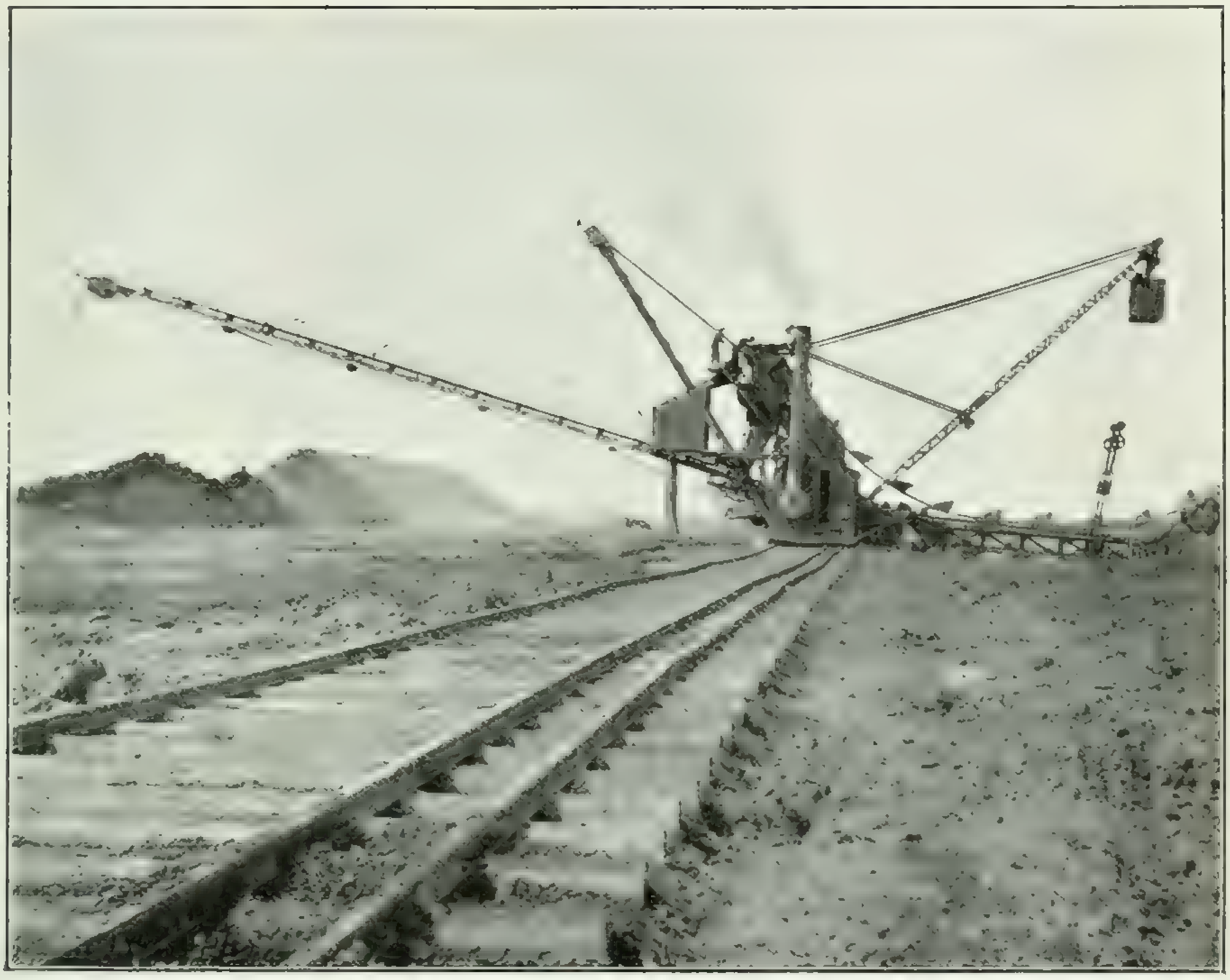
Cardiff Collieries, Limited.

The property controlled by this Company is situated 20 miles north of Edmonton, and has a spur connexion, 2½ miles long, with the Edmonton and Athabaska branch of the Canadian Northern railway. By means of this branch shipments may also be made over the Canadian Pacific and the Grand Trunk Railway systems.

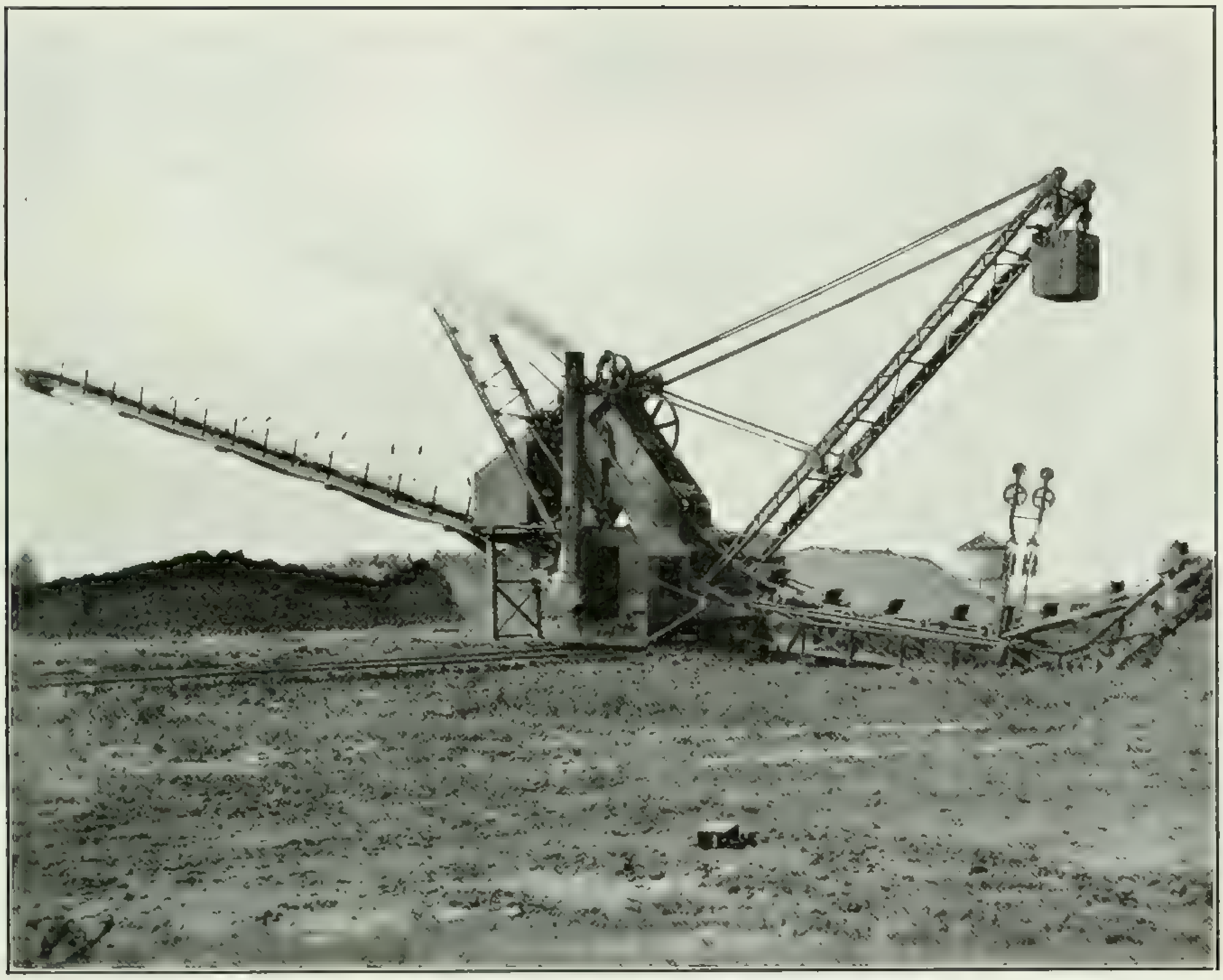
At the present time, this Company owns 340 acres of coal lands, and besides has under lease 290 acres, or a total of 630 acres in all. Based on an average thickness of 8 feet of coal, the estimated tonnage underlying this area is placed at 6,000,000 tons, of which amount probably 300,000 tons has either already been worked out or is stand-



Tofield Coal Co., Tofield, Alta. Stripping machine.



Tofield Coal Co., Tofield, Alta. Stripping machine.



Tofield Coal Co., Tofield, Alta. Stripping machine.

Tofield Colliery, Tofield, Alta. Open cut coal mining.

ing on pillars. The seam of coal that is being worked is known as the Cardiff seam, and comes within the "lignite" classification. It lies comparatively near the surface, and is overlaid by 50 to 60 feet of soil and strata.

The seam itself is practically level with a slight dip in a southeasterly direction, and is remarkably free from faulting. The entrance to the mine is by a slope opening, 18 feet wide and 7 feet high.

The coal tipple, which is a modern one, is built of wood. It is provided with an automobile car haul, which elevates the mine cars from an assembly landing in the slope, to the top of the tipple, and is operated by an engine of 125 horse-power. The screens are 14 feet long by 6 feet wide, and make screened, run of mine, egg, nut, and slack coal. The coals, as prepared for the market, are of excellent quality, great care being exercised that the coal is free from shale or other impurities. As a large proportion of the coal is shipped in box cars, an Ottawmwa mechanical box car loader is used.

The underground workings are laid out on the pillar and stall system. The main entry is driven 10 feet wide, and rooms are 20 to 30 feet in width, with 10 ft. pillars. By this method, it is claimed that 70 per cent of the coal is extracted in the first working, and from 20 to 25 per cent of the pillars subsequently recovered. The coal is mined by electrically driven machines of the Morgan-Gardiner and Sullivan type.

Tofield Coal Company.

It was decided to take a twenty ton sample of coal from the property operated by this Company, in order to test its commercial fuel value when used in the gas producer. This Company has surface and coal rights over 1,300 acres, and also controls the coal rights of an additional 160 acres. The town of Tofield is situated on the main line of the Grand Trunk Pacific railway, 41 miles east of Edmonton. It is also at the junction of the Calgary branch of the Grand Trunk Pacific railway.

The property of the Tofield Coal Company presents an example of the so-called "stripping" type. The coal is overlaid by so light a covering of soil or strata, that the overburden may be removed, and the exposed seam excavated, by open-cut or quarrying methods. The coal underlies a large area to the east of Edmonton, and its geological features have been described by Mr. D. B. Dowling of the Geological Survey, in his memoir on the Edmonton field. Its occurrence presents many features, interesting not alone from a geological point of view, but also on account of its position and accessibility. This latter consideration should have an important bearing in considering the possible introduction of gas producers in connexion with domestic, as well as industrial requirements, within the city of Edmonton, and also in the possible establishment of clay product, and other manufacturing industries.

Underlying the property controlled by the Tofield Coal Company, the presence of three seams of coal has been recognized. Of these the upper seam averages 8 to 10 feet in thickness, and, in the holdings of the Tofield Coal Company, represents an estimated tonnage of 20,000,000 tons. The second seam, which is 6 feet in thickness, is found at a depth of 208 feet, and contains an estimated tonnage of 14,000,000 tons. The third seam is 5 feet in thickness, and, in the area controlled by the Tofield Company, contains an estimated tonnage of 12,000,000 tons. At present all coal being mined is from the upper seam, which, as already stated, is worked by open-cut methods. The following section was measured on August 7, 1912, at a point in the northwest quarter of section 26, ranges 18-50.

	Ft.	In.
Top clay and surface soil	4	0
Boulder clay	3	0
Shales, dark grey in colour	3	0
Coal	9	0
Pavement, shale.		

The exposed face of the coal has very little of impurities, the bands of fireclay or shale seldom exceeding 1″ in thickness.

During the summer months, when the demand for coal is light, the overburden is stripped by means of mechanical excavators. During the remainder of the year, when the demand is greater, the coal itself is worked. Of the two mechanical excavators installed by the Tofield Coal Company, the first was a 60 horse-power Ledgerwood drag line machine, capable of handling 100 cubic yards per hour. More recently a 125 horse-power Lubeck excavator, with a capacity of 250 cubic yards, per hour, was installed.

Gainford Collieries, Limited.

This colliery, which is being opened up for a large output, is situated 58 miles west of Edmonton on the main line of the Grand Trunk Pacific railway and can thus ship coal over the Canadian Pacific and Canadian Northern systems. Being situated in a district, newly opened up, and since the coal appears well adapted for use in the gas producers it was deemed advisable to secure a twenty ton sample to be tested at the Fuel Testing Station at Ottawa. Indeed, the question of installing a gas producer at the mine, and of piping the gas to Edmonton, has already been under discussion.

The coal area controlled by the Gainford Collieries, Ltd., comprises 2,500 acres of freehold coal lands, and 13 full sections of coal lands held under lease. There are two seams of coal on the property of this Company. One of these has an average thickness of 8 feet, while such drilling as has been done appears to indicate that the underlying seam has a thickness of over 6 feet. The seam of coal now being worked at Gainford has also been opened up at Wabamun lake, Fallis, Gainford, and Entwistle. At the last named place the coal is being developed by the Pembina Coal Company. The mine at Gainford is being developed through two shafts. The main shaft is 24 feet in length by 12 feet in width, and has 3 compartments, two of which will be used for hoisting and one for men and material. The ventilating shaft is 9′-6″ in length and 6 feet wide. In sinking the air shaft the following section was exposed.

	Ft.	In.
Surface soil	14	0
Sandstone	121	0

The following section of the seam was taken at the face of the main entry on August 10, 1912.

Roof, sandstone.

	Ft.	In.
Coal, good	1	2
Parting of shale		½
Coal, very good, hard and bright	5	6
	6	8½

Pavement, shale, light grey in colour.

The method of mining is the three entry system. Rooms are 15 to 20 feet in width, this width being determined by the character of the roof. Pillars are to be 30 feet in thickness.

The coal cutting machinery, which is being installed, is the Sullivan Chain type electrically driven.

In looking over the commercial centres of the Province of Alberta, and in considering the rapidly increasing population of the cities and towns, the writer was impressed by the possibilities of the coals of the Red Deer valley, if used in the gas producer for the development of heat and power. The existence of these deposits has been known for many years, but, owing to lack of transportation facilities, these deposits have, until recently, remained practically undeveloped.

Within the last 5 years, the Canadian Northern Railway system has been extended from Vegreville to Stettler, is now worked to Drumheller, and is being constructed to Calgary. The building of this extension has naturally attracted attention to the coal of the Red Deer valley, and development of the seams now extends from Munson to the mouth of Rosebud creek. Below Munson on the main line of the Canadian Northern railway, the Munson Collieries, Limited, are prospecting the seams of coal under their property by means of drilling, while, farther along the line, the town of Drumheller is becoming the centre of a coal mining district. At the time of the writer's visit, September 8, 1912, the following coal mining companies had commenced active operations.

The Midland Coal Company.
The Trembles Coal Company.
The Drumheller Coal Company.
The Newcastle Coal Company.

Six miles beyond Drumheller, the Roseden Coal Company and the Rosedale Coal and Clay Products Company are now working coal, and are conducting extensive development operations on their properties.

After due consideration, it was deemed advisable to select a twenty ton sample of coal for the Fuel Testing Station from the mines of the Rosedale Coal and Clay Product Company, as being a good representative coal from this district. The coal areas of this Company comprise 14,000 acres of leased coal rights, and are situated in townships 28 and 29, range 19, west of the 4th meridian. Up to the present time, two seams of coal have been proven on this property, but, as yet, have not been designated by any distinctive names. No. 1 seam has an average thickness of 4 feet, and No. 2 seam a thickness of 7 feet. Both of these seams have but a slight angle of inclination, and offer very advantageous conditions for economic mining of the coal. The following section of the lower or No. 2 seam, was taken on September 9, 1912, at the bottom of the air shaft.

Roof 8″ hard shale above this sandstone rock.

	Ft.	In.
Coal	0	4
Clay, parting	0	1
Coal, bright and clean	2	6
Coal, dull and hard	1	2
Band of clay and shale	0	7
Coal intermixed with shale	0	6
Coal, good, hard, bright	3	2
Total	8	4

IV.

CHEMICAL LABORATORY OF THE FUEL TESTING STATION.

Edgar Stansfield,

Chemist.

It is a matter for great satisfaction to be able to state that, during the past year, steps have been taken to remedy the present totally inadequate accommodation provided for the chemical laboratory of the Fuel Testing Station. Six rooms have now been provided for this laboratory in the extension that is being made to

the original building; and not only are these rooms rapidly nearing completion, but the installation of equipment for the same is well under way. It is confidently expected that it will be possible to commence regular work in the new building early in 1913.

All the work tables, fume cupboards, store cupboards, shelves, etc., required for the new laboratory have been specially designed by the chemist, great care being taken to utilize to the utmost advantage all available space, and to facilitate the efficient working of the laboratory in the future.

During the past year, all analyses of fuel, gas, and ashes required in connexion with the regular testing work of the Division, have been conducted in the old laboratory. In addition, the samples of peat taken by Mr. Anrep, in connexion with his field work, have been tested, as well as a number of fuel samples submitted by outside parties. The interruption consequent upon the alterations and additions to the building made it impossible, however, to carry out any chemical work in the laboratory during the last few months of the year.

The laboratory equipment has been further increased by the purchase of a number of small pieces of apparatus, and also by an electrically heated still of about four litres capacity. This still, designed by the writer, which was primarily intended for distilled tar, is described below.

Three special investigations have been carried out during the year. The first of these, relating to the determination of moisture in fuels, has been fully described in a previous report; the other two were concerned with the tar from a peat gas producer. The alterations being made to the plant have prevented the completion of either of these two latter investigations, but it is hoped that they may be continued in the new building.

In one of these investigations, mainly conducted by Mr. Blizard, experiments were made in order to determine the effect of passing gas containing tar fog through a strongly heated quartz tube, not only when the latter was empty, but also when it contained asbestos or peat coke. The effect of passing the gas through a cold tube, or series of tubes, with different sizes and shapes of constrictions, was also studied. The results may be summarized by stating that, as far as could be determined by the experiments, the tar was not completely decomposed by passing through a column of coke at a temperature higher than is usually attained in a peat producer. This investigation also furnished a clue to the principle on which a satisfactory apparatus for the removal of the tar from the cold gas might be constructed.

The second investigation had for its object the examination of the tar obtained from the cleaning system of a peat gas power plant, in order to determine its commercial possibilities. In this connexion a number of fractional distillations of samples of tar were made.

AN ELECTRICALLY HEATED TAR STILL.

The complete still may be considered as consisting of three parts: (1) the heating ring on its stand; (2) the still or retort, and (3) the surrounding jacket.

The heating ring on its stand, with switches, etc., all complete, is shown in Plate V. It consists essentially of an annular casting, standing on the upper of two iron plates, separated from each other by asbestos millboard and cardboard. The four legs are fastened to the lower iron plate. The annular casting contains 16 vertical holes, in each of which is placed a heating coil. Each heating coil contains about 14 feet of No. 24 gauge nichrome wire wound on a threaded, fireclay bobbin, $4\frac{1}{4}''$ long and $5''$ diameter, having a flange at each end of almost $\frac{7}{8}''$ diameter. The heater was designed for use with either alternating or direct current at 110 volts. The coils, which are numbered consecutively 1 to 16 around the ring, are wired up as shown diagramatically in Fig. 1. It can be seen in Plate V that the connecting wires

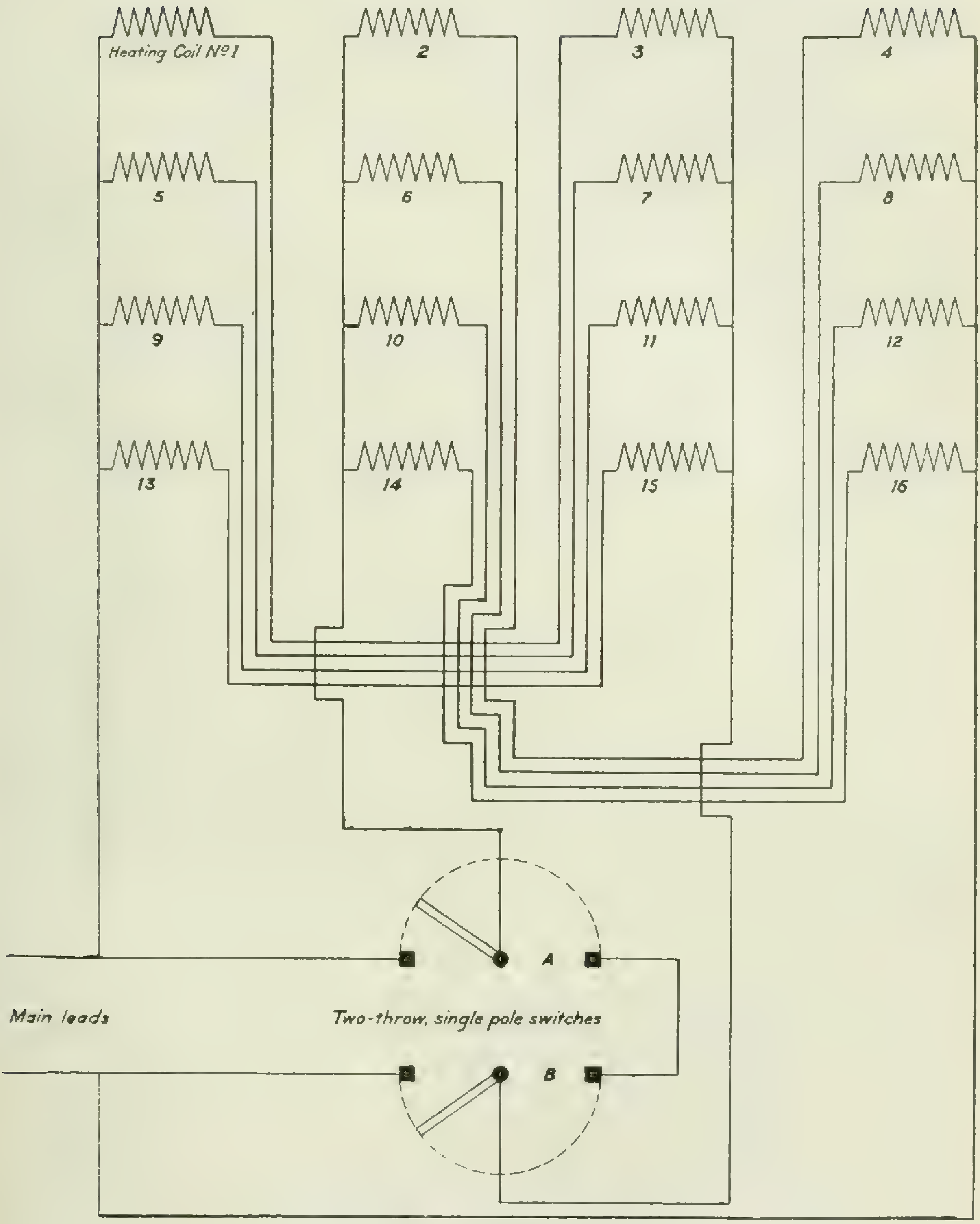


Fig. 1.—Wiring diagram for electric still.

are enclosed in glass tubes wherever necessary to avoid risk of short circuits. When switches A and B are both thrown to the left, as in Plate VII, all sixteen coils are heated in 8 parallel sets of 2 in series, and the maximum current passes through the heater. When only switch A or switch B is to the left, as in Plate VI, the alternate coils only are heated, in 4 parallel sets of 2 in series, and half current passes through the heater. When switches A and B are both closed on the right, as in Plate V, all the soils are heated in 4 parallel sets of 4 in series, and quarter current passes through the heater. Extra current regulation can be obtained by means of an external rheostat, if desired. The heating ring, which is fluted on the outside to avoid unnecessary weight of iron, is carefully heat insulated by means of asbestos, except on the top which is left exposed.

The still itself, which is shown in position in the heating ring in Plate VI, is made from a 9″ length of 6″ pipe. The bottom end is closed with a screwed in plug, and the top end by a lid which bolts down on to a collar round the top. There is a discharge pipe in the bottom closed by a simple valve, to allow any water, which collects under the tar when it is melted, to be run out before the distillation is begun, and also to enable the hot pitch to be run out at the end of the distillation. On the top of the still can be seen a small still head, and orifices for the introduction of tar and for thermometers. The total capacity of the still is about 4 litres.

The outside jackets are made of sheet iron, lined with about ⅜″ of asbestos. The complete still, ready for use, is shown in Plate VII.

This still was built up at the Fuel Testing Station, Mr. A. W. Mantle looking after all machine work and general construction.

V.

INVESTIGATION OF PEAT BOGS.

A. Anrep,

Peat Expert.

During the field season of 1912, the investigation of the peat bogs of the Provinces of Ontario and Quebec was continued, in order to ascertain the extent, depth, and quality of peat contained in the various bogs. In connexion with this work, the writer left Ottawa on May 1, Mr. A. Hannington acting as temporary assistant throughout the season. The following statement briefly summarizes the results of the season's investigation.

QUEBEC PEAT BOGS.

The peat bogs examined in Quebec during part of May, June, July, August, September, October, and part of November, 1912, were:—

(1) The large Tea Field peat bog, situated 1½ miles northwest of Huntingdon station, on the Grand Trunk railway, in the township of Godmanchester, county of Huntingdon. The total area covered by this bog is approximately 5,000 acres, the depth of the bog varying from 4 feet to 14 feet.

(2) The small Tea Field peat bog, situated 3½ miles northwest of Huntingdon station, on the Grand Trunk railway, or 1½ miles southeast from Lake St. Francis, in the township of Godmanchester and county of Huntingdon.

The total area covered by this bog is, approximately, 4,000 acres, the depth of the bog varying from 1 foot to 13 feet.

(3) Lanoraie peat bog, situated on the west and east side of Lanoraie station, on the Canadian Pacific railway, in the counties of Berthier and Joliette.

The total area covered by this bog is, approximately, 7,000 acres, the depth of the bog varying from 1 foot to 27 feet.

(4) St. Hyacinthe peat bog, situated about 3½ miles southeast of St. Hyacinthe, on the Canadian Pacific railway. The southern extremity of the bog extends to within 1,000 feet of the railway. This bog is in the township of St. Hyacinthe, in the counties of St. Hyacinthe and Bagot.

The total area covered by the bog is, approximately, 3,800 acres. the depth of the bog varying from 1′-4″ to 14′-8″

(5) Rivière du Loup peat bog, situated about 1½ miles south from Rivière du Loup station, on the Intercolonial railway, in seigniories Terrebois, Rivière du Loup, Leparc, and township of Withworth, county of Temiscouata.

The total area covered by this bog is, approximately, 7,300 acres, the depth of the bog varying from 1′-8″ to 32′-0″.

(6) Leparc peat bog, situated about 3 miles east of Rivière du Loup station, on the Intercolonial railway, in the seigniory of Leparc and county of Temiscouata.

The total area covered by this bog is, approximately, 200 acres, the depth of the bog varying from 1′-4″ to 13′-8″.

(7) Cacouna peat bog, situated about 5 miles east of Rivière du Loup station, or about 500 feet southwest of Cacouna station, on the Intercolonial railway, in the seigniory of Leparc, county of Temiscouata.

The total area covered by this bog is, approximately, 300 acres, the depth of the bog varying from 3 feet to 17 feet.

(8) Rivière Ouelle peat bog, situated about 1 mile northeast from Rivière Ouelle station on the Intercolonial railway, in the township of Rivière Ouelle and county of Kamouraska.

The total area covered by this bog is, approximately, 4,100 acres, the depth of the bog varying from 1′-8″ to 27′-4″.

(9) St. Denis peat bog, situated about 1½ miles south from Rivière Ouelle wharf, on the Intercolonial-Rivière Ouelle Wharf branch line in the township of Rivière Ouelle and county of Kamouraska.

The total area covered by this bog is, approximately, 300 acres, the depth of the bog varying from 1 foot to 22′-8″.

The approximate total area investigated in the Province of Quebec during the season of 1912 is 32,000 acres. The bogs are well situated as regards freight facilities and markets, most of them being adjacent to railways and in the vicinity of large towns.

ONTARIO.

During the progress of the above investigation, I also investigated, during July, a small peat bog near Sellwood, Ontario.

Sellwood peat bog is situated about 1¼ miles west from Sellwood station, on the Canadian Northern railway, in the township of Hutton and district of Nipissing.

The total area covered by this bog is, approximately, 8 acres, the depth of the bog varying from 4 feet to 8 feet.

During the course of the investigations in the vicinity of Sudbury and Sellwood, no large bogs were found.

During the latter part of August and the first part of September, I visited the newly installed peat plant, at that time nearing completion, on the Government peat bog at Alfred, Ontario. I also visited the Farnham peat plant at Farnham, Que., where a 2 hours' run was witnessed.

Detailed descriptions, delimitations, profiles, and maps will be published in a separate report.

VI.

PETROLEUM AND NATURAL GAS RESOURCES OF CANADA.

Frederick G. Clapp and L. G. Huntley.

SCOPE OF THE REPORT.

The instructions were to write a report on the petroleum and natural gas resources of the Dominion, which will outline the history of developments, status of production, stratigraphy, drilling methods, markets, methods of transportation, quality, utilization, and such other technical details as are necessary in exploiting these resources to the best advantage. Such a report is of value to an operator in one field who may wish to be informed on conditions or methods existing in some other field, and it is needed furthermore for a layman who may intend entering the petroleum or natural gas business or associated enterprises, and who may demand truthful information regarding conditions or methods in various parts of the Dominion.

WORK DONE TO DATE.

The work referred to in this report has, up to the present, consisted chiefly of field-work. This work was commenced in May, 1912, and was prosecuted intermittently during the summer and autumn. All provinces in Canada which have produced any petroleum or natural gas were visited, and references thereto will be included in the report. The statements outlining existing conditions are corrected up to the summer of 1912.

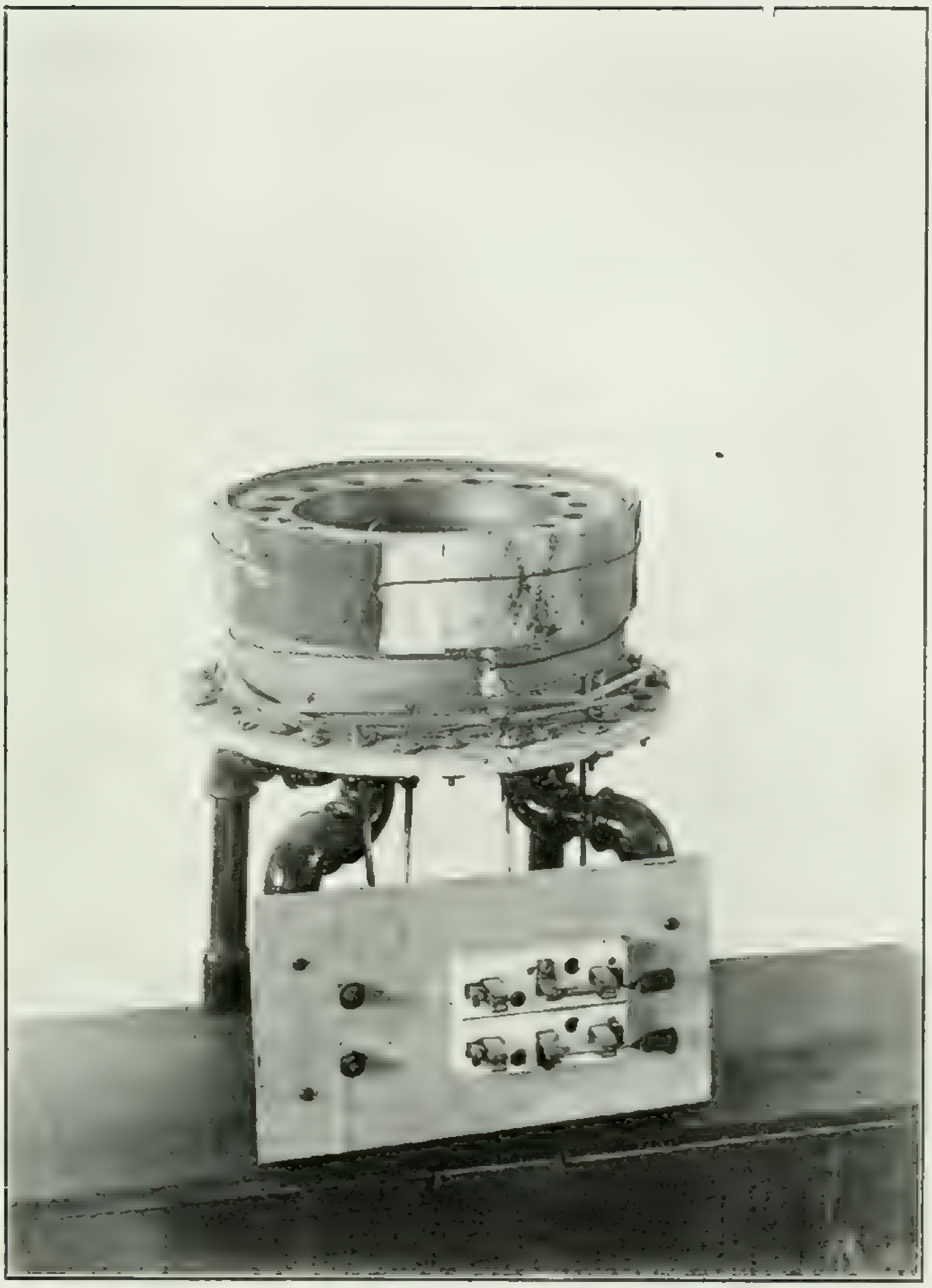
SUMMARY OF RESULTS.

The conclusions arrived at and information obtained may be summarized under the following outline:—

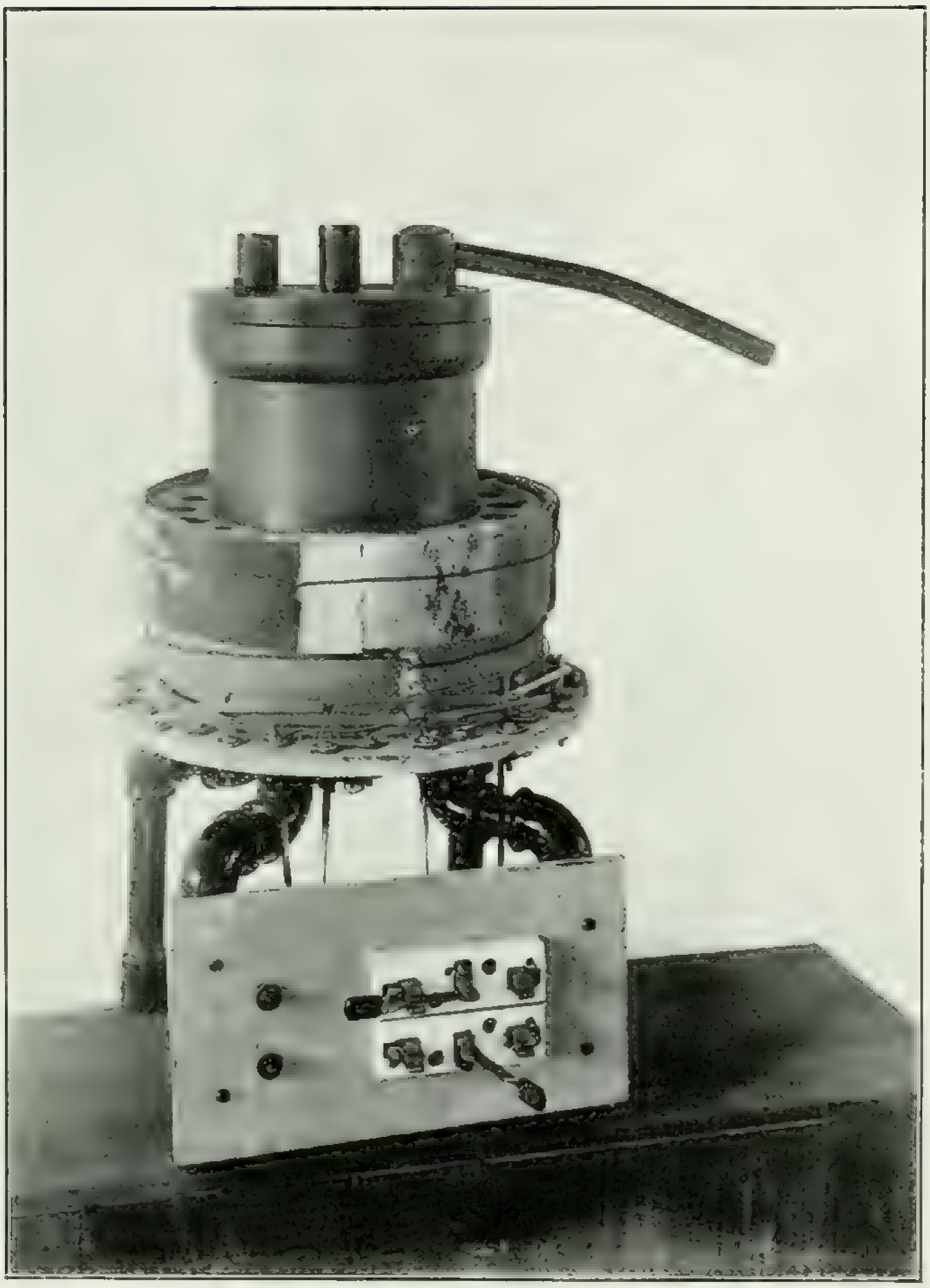
Uses of Petroleum.—Ever since the discovery of petroleum in commercial quantities in America, the number of uses of both the crude and refined products have been growing, until at present the production is far from sufficient to supply the demand. In a work such as the present one, it seems essential to give an outline of the uses of petroleum, in order to make clear what may be done by the industry in meeting the present demand; consequently this consideration will be taken up in a special chapter. It will include a discussion of the growing demand for gasoline, and of the methods used for extracting this substance from certain types of natural gas in the oil fields. Natural gasoline plants are in frequent use in the United States, but are very rare in Canada.

Classification and Value of Petroleum.—It may not be generally understood that a great difference exists in the character of petroleum in various parts of the Dominion, and between the Canadian oils and those of other countries. Most oils are suitable for special purposes, and consequently the pipe line companies have classified them into a number of grades depending on the character and demand in different fields, and have set a price for each particular grade. This price is changed from time to time according to the changing supply and demand.

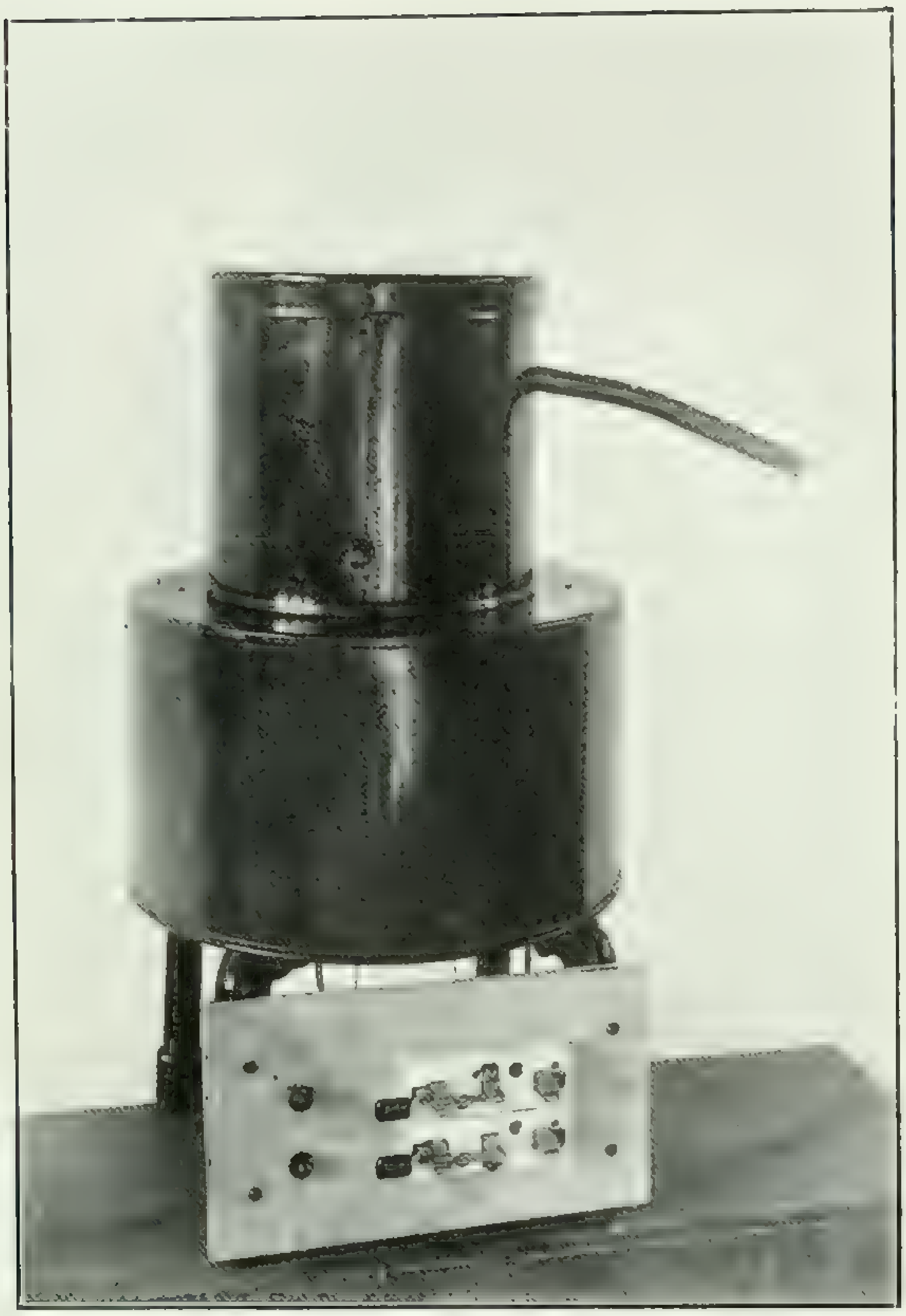
Geological Occurrence of Petroleum and Natural Gas.—While the oil business has very generally been viewed by the public as a gambling enterprise, and while many companies have conducted it as such, we are now able to say that the days of taking great chances are past. A careful study of local conditions will now enable an expert to judge to a considerable extent what may be expected of any particular property. While it is not possible to absolutely predict whether a well drilled at a particular point



Heating ring.



Heating ring and retort.



Complete still.

will produce oil, we can nevertheless gain a fair knowledge of the conditions prevailing under a property of any size, and for this purpose a detailed knowledge of the geology is necessary in all cases. Geological details, where they are known, are given in the special chapters describing the different fields, but in addition the report will summarize the geological conditions common to all the fields, explaining the relations of the production to different types of geological structure.

Control of Oil and Gas Territory.—Various methods are in use in different parts of the country by which companies and individuals acquire the right to drill on prospective oil and gas land. The methods differ mainly on account of the various ownership conditions in the different provinces; and in addition there is much difference in the form of lease within every particular province. The report will outline the various methods and conditions of acquiring and holding territory.

Methods of Drilling.—Many different methods of drilling are in use in different parts of the world, and a discussion of these is absolutely necessary in order to give a clear understanding of the expense of operating. While a full discussion would fill many volumes, enough will be said to meet the needs of the industry in Canada. This chapter will also include a discussion of the cost of drilling, and of the differences between drilling by contract and drilling done directly by the operating company in various fields.

In any field it is important to know what type of drilling rig is used in any other particular field. The particular fuel used in drilling must be known, the methods and size of casing, and also the water problems which will be encountered are important. A driller also wishes to know what time will presumably be consumed in drilling the well, what fishing tools are practicable, and what sort of packers, liners, strainers, and other accessory equipment are common. It is also important, in each particular field, to know whether the wells are generally shot.

Transportation and Storage.—Since a great many different methods exist for storing petroleum and for transporting it to the refineries or to the markets, and since these methods are not commonly understood except by people engaged actually in the petroleum business, a brief chapter will be devoted to the methods of transportation and storage. This will also include a description of the methods used in transporting natural gas to distant municipalities.

Measurement and Transportation of Natural Gas.—Much ignorance exists among those not associated with the natural gas industry, as to the methods by which gas is transported and the conditions prevailing; consequently this report will give a short chapter on the volume of gas wells, their measurement and methods used in determining the pressure.

Descriptions of Individual Fields.—It is planned to take up every oil and gas field in the Dominion, and individually to describe its geographic, topographical, and geologic situation. The character and amount of the production, with a brief history, the depth of wells, and drilling methods will be given in all cases.

Desirability of Keeping Good Records.—A feature of the oil and gas business, which is not commonly appreciated, but which is nevertheless very important, is that accurate records should be kept, not only of the depth of the sand and of the amount of production, but also of the exact depth at which each formation is encountered in drilling the wells, the depth at which they were cased, whether particular seams of water, oil, or gas were encountered, and such other information as may be valuable to a driller in sinking other wells in the same region. While the importance of such considerations may not be apparent in all cases, it is possible to say that, when the records throughout a particular field are collected and correlated by an expert, they never fail to give information of future value, which can not be gained in any other

way. The writers of this report, having visited all the fields in the Dominion, have cause to regret that records as a rule are not kept carefully, accurately, or systematically, although certain companies must be excepted from this statement. It is hoped there will be early improvement in this matter.

Conservation of Natural Gas.—The writers are firm advocates of the movement for conservation of natural gas. By this should be understood conservation in its broadest sense, including prevention of actual waste, the abolition of wasteful methods of utilization, and the passage and enforcement of such laws as will assure the wisest possible utilization of gas for the best interest of all the people. While the waste of gas in Canada has not been as great as in the United States, this circumstance has been largely due to the fact that fewer fields have been developed. With the discovery of gas in large quantities at both ends of the Dominion, we should take care that the laws for its development and utilization are all that can be desired.

Bibliography.—An exhaustive bibliography has been prepared on the oil and gas developments of the Dominion, and this will form a part of the report. The bibliography is also an index to all literature on the subject so far as known.

SOUTHERN ALBERTA.

Status of Development.—Natural gas development in Alberta, which was started at Medicine Hat in 1891 by a well drilled in search of coal, has grown to large proportions within the past two years. The principal centres of production at present are the town of Medicine Hat and its environs, which produce from 25,000,000 to 30,000,000 cubic feet per day, and the Bow Island district, situated 40 miles west of Medicine Hat, which produces about 75,000,000 cubic feet per day. From the latter district a pipe line has been laid for the purpose of supplying the city of Calgary, 160 miles distant, and fourteen other municipalities along the route. No other gas of importance has been developed in southern Alberta.

Gas-producing Formations.—In the Medicine Hat field, the gas is found in several formations at depths ranging from 200 to 1,300 feet. The principal producing sand, however, is encountered at from 1,000 to 1,300 feet in depth. The rock pressure is about 560 pounds, and the volumes of individual wells are between 1,000,000 and 7,000,000 cubic feet per day.

In the Bow Island field the important productive stratum is encountered at about 2,200 feet in depth, and is generally correlated with the Dakota sandstone, although Dr. Eugene Coste believes it to be of Niobrara age. There are fourteen producing wells in this field, all owned by the Canadian Western Natural Gas, Light, Heat, and Power Company, Limited. The initial production ranges from 2,000,000 to 24,000,000 cubic feet per day per well, with a rock pressure of 800 pounds.

Cost of Drilling.—Compared with the cost of drilling in the eastern and mid-continent fields, the expense in Alberta is very high. In the Medicine Hat field the drilling of gas wells is contracted for at prices ranging from $6.50 to $8 per foot, depending upon the diameter at which the hole is finished. In the Bow Island field, the first wells cost as much as $20,000 each, and the present outlay is in the neighbourhood of $16,000 for a 2,200 ft. gas well.

Price of Gas.—Gas is sold for domestic consumption in the city of Medicine Hat for fifteen cents per 1,000 cubic feet, and for manufacturing purposes at five cents per 1,000 cubic feet. The city has, however, made a number of contracts for supplying gas to manufacturing plants free of cost for a five-year period. This appears to be a very short-sighted policy, in view of what is now known regarding the length of life of gas producing territory when drawn upon freely. Moreover the value of natural gas as a fuel is too great to justify its waste by being given away. The rates for natural gas in the cities of Calgary, High River, Lethbridge, Macleod, and other towns situated on the western Canada pipe line, are fixed at twenty cents per 1,000 for manufacturing and thirty-five cents for domestic purposes.

Present Drilling.—Owing to the high cost of operating and to several other conditions, most of the drilling is now being done by several large companies and by municipalities, the latter for advertising and local promotion purposes. The wildcatting to date has failed to discover any extensive fields besides those mentioned. These are, however, believed to be capable of great extension.

SOUTHWESTERN ALBERTA AND SOUTHEASTERN BRITISH COLUMBIA.

(Pincher Creek District.)

Status of Development.—The operations which were commenced in the Pincher Creek and South Kootenay Pass district in 1902, have resulted in the drilling of 17 or 18 wells up to the present time, ranging in depth from 200 to 1,900 feet. While two of these gave evidence of possibly proving small oil producers if they had been properly handled, the remaining wells never produced more than about a barrel a day at their best. In the summer of 1912, two companies were deepening old wells in a more or less desultory way, but no additional production had been encountered. Some wells are still rigged for pumping, however.

Productive Formations.—The seepages which occur in this district, and which led to the drilling and to the usual accompanying boom and stock-selling period, exude from what Dr. Dawson describes as a "somewhat anomalous occurrence of petroleum" in rocks of Cambrian age. It remains an occurrence of scientific interest only, since, even if oil had ever been found in quantity in rocks of this age, the greatly disturbed and faulted condition of the Pincher Creek and South Kootenay rocks must have precluded the possible existence of an oil reservoir of any importance.

Quality of Oil.—The small quantities of petroleum produced were of high grade, being about 42 degrees Baume, and contained a large percentage of light oils, but no sulphur. It is an interesting scientific fact that this and other "freak" fields commonly yield high grade oil.

NORTHERN ALBERTA.

Status of Oil Developments.—The immense seepages of tar and petroleum residue known as the "tar sands," which occur along the banks of Athabaska river and between that river and the Peace River country, have proved an alluring basis for oil prospecting, notwithstanding the belief of geologists who have visited the region, that oil would not be encountered near the outcrop of these sands, and furthermore notwithstanding the fact that no petroleum in commercial quantities has ever been found in rocks of similar age to those which occur below the Devonian limestone in this region; nevertheless drilling has been active in the vicinity of Fort McMurray and Fort McKay and in the intervening territory along the Athabaska river. Several of the wells, which have been sunk from near the top of the Devonian limestone and at the base of the Dakota or "tar sand," have encountered small pockets of thick tarry oil in the limestone; but up to the present time no oil has been recorded in commercial quantity in this north country. As an example of the futility of some of the efforts, it may be said that in June, 1912, one well at Fort McMurray was drilling in the Laurentian formation underlying the Devonian limestone.

Not all of the wells in the far north are so situated as to be absolutely futile. For example, a well drilling 80 feet west of the old Geological Survey well[1] at Pelican, on the Athabaska river, struck several good flows of gas; but of less volume

[1] Geol. Survey, Can., Vol. V, p. 1445. 1890-91
Geol. Survey, Can., Vol. X, p. 19 A.

than the first well. The old well is capped and used to furnish fuel for drilling purposes, and the present hole is being continued in hope of finding oil below the limestone, the gas having been cased off.

In June, 1912, fifteen or sixteen holes had been drilled between Athabaska Landing and Fort McKay, but no oil had been produced in commercial quantity. A number of companies formed for the exploitation of asphalt claims in this district have their headquarters in Edmonton, but as the lack of transportation facilities up to the present time has prevented the handling of such bulky material, their operations have consisted principally in stock-selling. The building of a railway to Fort McMurray, however, would make these deposits of considerable value for many purposes. A number of drilling outfits went north during the past summer to commence operations.

Geological Conditions.—The first exposure of Devonian limestone observed south of Lake Athabaska, occurs some 10 miles below the mouth of the Calumet river, and from near this point "tar sands," of an estimated thickness of from 50-250 feet, outcrop for many miles along the Athabaska river. The limestone, dipping to the south, disappears beneath the river near Crooked rapid, and the "tar sand," likewise dipping below the surface near Boiler rapids, probably constitutes the reservoir which contains the gas encountered at Pelican rapids. Continuing to dip southward, this formation lies at a depth of about 3,000 feet at Morinville, and near Calgary reaches an estimated depth of 5,000 feet. What is supposed to be the same sand has been discovered as the principal gas-bearing formation of southern Alberta, and in drilling for oil this horizon is the one desired by operators.

Status of Gas Developments.—The government gas well, drilled at Pelican Rapids in 1897, still has a pressure reported as about 500 pounds. The gas is used as fuel for drilling purposes. The well which is being drilled at present, 80 feet west of the old well, struck gas both in what was believed to be the Niobrara formation and also in the Dakota sand, but the gas was cased off and drilling continued in hope of finding oil.

The government test well at Athabaska Landing still shows a little gas bubbling through a hole full of water, although it never produced gas in any quantity, and did not reach the Dakota formation. The well which has been drilling at Morinville for the past five years has reached a depth of about 3,500 feet, and has found as yet only a small showing of gas in the upper part of the well. A dry hole was drilled some years ago at Edmonton to a depth of approximately 1,900 feet.

On June 18, 1912, a test drilled by the municipality of Tofield, 35 miles southeast of Edmonton, struck a small flow of gas, about 800,000 cubic feet, at a depth of 1,051 feet, without reaching the Dakota sandstone. A second well is now being drilled for the municipality. The success of the drilling at Tofield has led to the starting of a well by the town of Vegreville, about the same distance due east of Edmonton.

Methods and Cost of Development.—Development and drilling along the Athabaska river has been upon Government land. The expense of drilling, which is very great on account of the necessity of establishing camps and of the cost of transportation in this district, has made it difficult for an inexperienced man or one with small capital, to operate, most of the drilling being done by stock companies. A well on the Athabaska had already cost about $25,000 at a depth of 1,400 feet, and the end was not in sight. Both United States Standard and Canadian Standard rigs are used with 72 ft. and 56 ft. derricks, respectively. A number of second-hand pole-tool rigs have also been taken into the north country. Drilling for gas at Morinville, Edmonton, Tofield, and Vegreville is all done by means of United States Standard rigs, and operated, as a rule, by drillers from the United States.

The second well at Tofield is reported to have been contracted for at a rate of $10 per foot of depth, for a depth of 2,000 feet. Owing to the large tracts of land controlled by the railways and by various development companies, drilling will probably be done largely by such concerns, or by municipalities for local use, as is the case in the Medicine Hat and Bow Island districts.

The high cost of drilling in these fields is also partly accounted for by the necessity of casing to the bottom of the hole, on account of the caving nature of the formations passed through. This necessitates a very large hole, several strings of heavy casing of different sizes, and the long tedious work of "under-reaming." The high salaries which must be paid to drillers in these fields is also an added factor in the expense.

Future of the Alberta Fields.—Owing to the factors mentioned, combined with the great depth of hole necessary to test the Dakota or Niobrara formations in the belt situated between the gas development and the mountains, which in Alberta is the territory where oil supposedly will be found, this territory has remained practically untested. Several holes have been drilled at Calgary, resulting in only small quantities of gas, although none were of sufficient depth to test the strata which are productive at Bow Island, and to which the great asphalt seepages along the Athabaska river probably owe their origin.

The crest of the main arch of the formations passes about 100 miles east of Edmonton and appears to cross the Athabaska river in the vicinity of Crooked rapids. Medicine Hat and Bow Island lie near this crest, while Calgary and Edmonton are situated in a great trough which parallels the mountains. Dr. Eugene Coste calculates that to test the Dakota sand at Calgary would require a well approximately 5,000 feet in depth. As to whether the principal gas horizon is saturated with salt water in the bottom of this structural depression, and if so, how far up the eastern slope the water extends, is a matter which can only be determined by the drill. The history of most oil and gas fields of the world has shown that the "pay" formations contained large quantities of salt water in their lowest depressions, the oil pools occurring along the anticlinal flanks above the saturated zone, and being in turn bordered by the main gas pools higher on the slope of the anticlines.

While the foregoing remarks are intended to apply to the west side of the principal west Canada anticline, they will apply also to its eastern slope. Therefore, drilling in Saskatchewan, if conducted systematically at points recommended by an expert after a study of local geological structure and other conditions, may be expected to result in the development of petroleum in some localities. Meanwhile the rapid increase in population in Alberta is rendering necessary the development of the central gas belt stretching northward from Medicine Hat towards the Athabaska.

BRITISH COLUMBIA.

No oil or gas in commercial quantity has been developed in this Province. From a well drilled at the entrance of Otard bay on Graham island in the Queen Charlotte group of islands, a showing of oil and gas was encountered near the bottom of the hole, which in June, 1912, was between 600 and 700 feet deep. In this district much tar-impregnated limestone is exposed, but no oil production has been developed. Several dry holes were drilled in other localities at various dates.

MANITOBA.

While several wells have been drilled in the southern part of Manitoba, yet no oil or gas in commercial quantity has ever been discovered in this Province.

SASKATCHEWAN.

Status of Developments.—Several borings were made years ago in the vicinity of Regina in the Province of Saskatchewan,[1] ranging from 100 to 1,550 feet in depth, but accomplished no results except obtaining a small show of gas and large amounts of salt water. A well drilled at Moosejaw in 1911 reached a depth of 1,200 feet, and developed a small show of gas, but this likewise was discontinued on account of salt water. Land was leased in 1911 at Saskatoon and vicinity, and in the early part of 1912 a well was being drilled to test that territory. The tar seepages on Buffalo lake have been known for years, but reports of high grade oil north of Prince Albert have lacked confirmation. However, during the summer of 1911 a well was drilled by a lumbering firm operating about 120 miles north of Moosejaw on the Canadian Pacific railway. The well was drilled to a depth of 1,730 feet, and encountered a very good showing of dark oil at this depth in a coarse sandstone.

Prospects for Future Oil Development.—If an oil-bearing zone lies to the east of the anticline on which the main Alberta gas belt exists, it must be situated to a large extent in western Saskatchewan. Since the formations which are found saturated with salt water in wells drilled at Regina and Moosejaw appear to limit the probability of oil existing east of those cities, prospecting between them and the Alberta border probably offers the best chance for the operator.

The principal Alberta anticline may be explained as similar in structure in some respects to the well-known Cincinnati anticline which lies west of the Appalachian mountains in Ohio and Indiana. While the higher portions of certain porous strata along that anticline held great gas fields, the same strata somewhat away from the anticlinal domes have yielded large oil pools.

PROVINCE OF QUEBEC.

Status of Oil Developments.—In 1896 and 1897 and previous to those years, numerous wells were sunk on Gaspé peninsula for oil, the holes ranging in depth from a few hundred feet to an extreme of 2,700 feet. The numerous surface indications and the small showings of oil in wells, resulted in no production of commercial value and the field was abandoned. The area in which boring has been done extends in a northwesterly direction from Seal cove, on the north side of Gaspé bay to Falls brook on a branch of York river, 33 miles distant. Upwards of fifty-two wells were drilled,[2] the best of them having had an initial production of 24 barrels per day. There has been no oil development elsewhere in the Province of Quebec.

Status of Gas Development.—Surface seepages containing gas in the vicinity of Three Rivers, Nicolet, and a few other localities in the Province led to early drilling in search of their source. A few small gas wells were discovered, and at one time, in 1899, the production amounted to 55,000 or 60,000 cubic feet per day. The wells ranged in depth from less than 100 feet to 1,100 feet, extending into the Hudson River shales. At a later date other wells were drilled at St. Barnabé, and the gas was piped to supply the town of Three Rivers. Its installation in a factory, however, exhausted the gas and the field was abandoned in 1907.

Wells of small value have been reported at various times at Three Rivers, St. Barnabé, Yamachiche, Louisville, Nicolet, and St. Gregoire. Numerous tests have been drilled at Montreal and neighbouring localities, but none have developed gas sufficient to supply more than single houses. A test was drilled a few years ago at Laprairie to a depth of 2,700 feet, while another was drilled at St. Geneviève two years ago to a depth of 1,800 feet or more, neither producing oil or gas. The Province of Quebec gives no indication at the present time of developing fields of either petroleum or natural gas.

[1] Trans. Royal Soc. Can., Vol. IV, 1886, pp. 92-3-4.
[2] Geol. Survey, Canada, Vol. XV, 1902-3.

NEW BRUNSWICK.

Status of Gas Development.—In New Brunswick the Maritime Oilfields, Limited, has continued drilling, and has brought in some gas wells of large volume, which are piped to supply Moncton, a city of 12,000 inhabitants. The field is one of considerable promise, and the Company mentioned has a lease of 99 years on 10,000 square miles of supposed oil and gas territory. This Company has taken over the holdings of the New Brunswick Petroleum Company. The first gas went through the line on March 23, 1912, and Moncton is the only city in New Brunswick supplied with natural gas, although the gas is piped to the village of Hillsborough.

The development lies in the vicinity of Stony Creek. In July, 1912, there were 15 productive wells in the field, 14 of which produced gas. Several are pumping oil to the amount of one barrel or so per day, most of which is found near the east side of the belt. Twenty-five wells have been drilled in all. The production of the gas wells runs as high as 6,000,000 cubic feet per day, and one well had an initial production of 12,000,000. The present production of the field is reported to be 58,000,000 cubic feet of gas per day. The rock pressure runs as high as 500 pounds.

Productive Formations.—The surface strata in the New Brunswick field consist of Carboniferous sandstones and shales, under which Devonian sandstones and shales are productive. The oil and gas comes from three groups of sands, each consisting of a number of lenses.

Methods and Cost of Drilling.—Wells in the Stony Creek field range from 1,200 to 2,000 feet deep. They are now spaced up to half a mile apart, although at first they were sometimes placed only 600 feet apart. The Pennsylvania method of drilling is used exclusively, with 72 ft. standard derricks. The usual cost is about $10,000 for each well.

Character and Price of the Gas.—The gas is very dry, and analysis has proven it unsuitable for the manufacture of gasoline. It is sold in Moncton and Hillsborough for domestic consumption at forty cents per thousand, and for gas engine use at twenty-seven cents per thousand.

Status of Oil Development.—Drilling in the oil fields at Dover and Memramcook was commenced in 1901 and a pumping area of 24 square miles between the tidal water of Petitcodiac and Memramcook rivers was developed, but the wells had extremely small production and have long since been abandoned.

The oil produced in the Stony Creek gas field is retailed locally for $4 per barrel, although most of it is sold to the Intercolonial railway at $1.75 per barrel for making Pintsch gas.

ONTARIO.

Status of Oil and Gas Development.—Drilling in the Ontario oil and gas fields commenced in the early sixties, coincident with the development of the prolific fields of northwestern Pennsylvania. The gas fields in Welland and Haldimand counties were developed, and more recently have been extended westward along the lake shore in a belt over 90 miles long and from 3 to 4 miles in width. Some good gas wells have also been drilled at Canborough and Caistorville in Haldimand county. Meanwhile the older gas-producing districts of those counties have been practically exhausted. While new production will be developed from time to time in small areas, and old fields enlarged to some extent, yet the production, both of petroleum and natural gas, in Ontario, is on the decline, and the total depletion of the underground supply is approaching. There may be some hope of discovering oil in the Trenton limestone by deeper drilling, but as yet no oil or gas has been found in quantity in this formation in Ontario.

In Welland, Haldimand, Norfolk, and Elgin counties, the larger companies are making strenuous efforts to discover gas. In Haldimand county some new gas has

been developed at Selkirk, and along the lake front in this vicinity, and also at Canborough in the northern part of the county. A gas field has also been developed within the past five or six years in Tilbury, Romney, and Raleigh townships in Kent county. The gas from this field is consumed in Kent, Essex, and Lambton counties. In Norfolk county the Dominion Natural Gas Company has developed a gas field south of Simcoe, and this Company is trying to extend it southwest to Port Royal and Port Rowan. The gas is piped to Hamilton and intermediate points. At Delhi in the same county a local company has drilled a half dozen gas wells inside the town limits within the past two years, the gas being used for local consumption. In Elgin county the companies are developing a promising pool in Bayham township in the vicinity of Vienna and Port Burwell. Pipe lines from this district supply the towns of Tilsonburg and Aylmer.

The oil production in the vicinity of Leamington in Essex county was abandoned in 1907, the district having been flooded by salt water. The prolific pools at Petrolia and Oil Springs in Lambton county continue to produce, showing a steady annual decline, as no new wells are being drilled. The same applies to the Bothwell field in Kent county, which exhibits the same characteristics as the pools in Lambton county. Careful methods of production, combined with very favourable underground conditions, have made the production of these pools a remarkable one, considering the small average production per well. In 1910 a new oil field was discovered and is being developed in Onondaga township, Brant county. The field also produces some gas; but owing to the character of the productive formations, the composition of the oil, and the rapid decline of the gas pressure, the pool does not promise as long a life as that of the older fields.

While the former oil pool in Romney township, Kent county, has been abandoned, a large gas production has been developed in this and in Tilbury and Raleigh townships, and is used to supply domestic consumption in Kent, Essex, and Lambton counties. A little gas is still piped from the vicinity of Dutton and utilized in Kent county.

Productive Formations.—The gas from the Welland, Haldimand, Norfolk, and Elgin County fields is all found in the Clinton and Medina formations, at depths varying from 500 feet in Welland county to 1,400 feet in Bayham township in Elgin county. The Tilbury-Romney pool, however, produces gas from just below the Big Lime, in depth from 1,425 to 1,450 feet. The Clinton and Medina formations west of Chatham are too broken and shaly to contain oil or gas.

Gas Production and Pressures.—In both Caistor and Canborough townships in Haldimand county the rock pressure averages 200 pounds, while the wells produce from 46,000 to 800,000 cubic feet per day. At Selkirk the pressures are about the same, although originally the initial pressure was near 500 pounds. The wells average less than 200,000 cubic feet initial production. A few small gas wells at Middleport and Caledonia average from 40 to 130 pounds pressure, with correspondingly small production. The six gas wells at Delhi, Norfolk county, produce 2,000,000 cubic feet per day, and have a rock pressure of 375 pounds, this having been initially over 500 pounds. The pressures in the Simcoe pool were initially from 560 to 650, although they have declined to about 350 pounds at present. The wells range in production from 15,000 to 500,000 cubic feet per day. A similar condition is true of the Vienna pool in Bayham township, Elgin county, although the initial pressures here were as high as 780 pounds, with correspondingly high production. The field has been drawn upon for only a year, since the completion of the pipe line to Tilsonburg. These fields all produce from the Clinton and Medina formations. The Tilbury-Romney pool in Kent county produces about 15,000,000 cubic feet per day from approximately 110 producing wells. The pressure in this district is about 600 pounds.

Production and Abandonment of Oil Wells.—The oil production in Lambton county, coming from the famous Oil Springs and Petrolia pools, amounted in 1912 to about 200,000 barrels. Production is decreasing regularly, and wells are being abandoned from the outer edge of the pool inward. In the Petrolia pool about 4,000 wells are still producing, as against 7,000 in 1910. The abandonment has been at a slightly less rate in the Oil Springs pool. No water problem has developed, and this field exhibits the comparatively rare phenomenon of an oil pool declining from the single cause of the exhaustion of the underground supply. No new wells are being drilled in Lambton county. The Bothwell pool in Kent county is exhibiting similar characteristics. The field still produces from 2,500 to 3,000 barrels per month, and shows no sign of exhaustion, although no new wells are being drilled. At Dutton, some oil is still being produced from the Medina formation, but the pool is on the decline and no new production is taking its place.

Wells in the new field in Onondaga township, Brant county, for which large predictions were made, have declined rapidly. The oil comes from a close, fine-grained sand, and since the gas is being drained from the pool rapidly, the production of the oil wells is declining, although the average is kept up to some extent by drilling new wells. In 1912 the production of this field was about 2,500 barrels of oil per month, and about 10,000,000 cubic feet of gas per month was being used in Brantford and the vicinity from this pool. The initial rock pressure of 235 pounds when the pool was discovered two years ago has declined to 175 pounds. The oil wells have an average production of one barrel of oil per day, all being pumpers. Wells are spaced too closely in most parts of the pool. A plant for the recovery of gasoline from the casing-head gas of this pool has been erected, but in July, 1912, it had not been operated.

PLANS FOR COMPLETION OF REPORT.

Office work is now being carried on by both of the authors as continuously as possible without interfering with other necessary work, and it is hoped the complete report may be ready for the press within a few months. Although this summary report contains no illustrations the complete monograph on "The Petroleum and Natural Gas Resources of Canada" will contain numerous illustrations of the fields, of methods employed in the business, and also maps showing distribution of petroleum and natural gas fields, pipe lines, refineries, and other data of importance. Quite a number of well records have been collected from various parts of the Dominion, and these also will be included under the respective fields. Some mention will be made of the possibilities for petroleum in the northern provinces of the Dominion, which have never been tested and which are not mentioned in this summary report.

I.

ORE DRESSING AND METALLURGICAL DIVISION.

G. C. Mackenzie.

Chief of Division.

During the first few months of the year, the laboratory was operated for the experimental testing of the four magnetic iron ores noted below.

After these tests were completed, the plant was dismantled in order to prepare for the equipping of a larger and more complete testing laboratory; a short description of which will be found at the end of this report.

List of Ores Tested During the Year.

Name of ore and number of test.	Locality.	Shipped by	Weight of shipment.
			Tons.
11. Bessemer	Lot 4, con. VI, township of Mayo, county of Hastings, Ont.	Mines Branch, Department of Mines.	1¼
12. Childs............	Lots 11 and 12, con. IX, township of Mayo, county of Hastings, Ont.	Mines Branch, Department of Mines.	2
13. Rivière des Rapides..	Seven Islands bay, county of Saguenay, Que.	Department of Colonization, Mines and Fisheries, Quebec.	1½
14. Carter	Carter, West Virginia.	J. W. Evans, Esq., Belleville, Ontario.	½

TEST No. 11.

Bessemer Ore.

The ore consists of a fine grained magnetite, with an associated gangue of calcite, garnet, and epidote and other silicates.

The magnetite and gangue are, however, not in a state of intimate mixture, the latter occurring in veinlets and irregular masses throughout the matrix. For this reason the ore may possibly respond to dry magnetic separation after relatively coarse crushing, although the grade of concentrate and recovery of original iron, would be lower than the grade and recovery obtained by wet separation.

Dry separation at ¾" or ½" size might result in obtaining a 50 per cent iron concentrate, which product would, in all probability, not require briquetting, but this method of milling would necessitate a preliminary drying of the crude.

The results of the wet magnetic separation test given hereunder, demonstrate the value of this process in concentrating ores of low iron content. Not only has a concentrate containing over 67 per cent of iron been made, but the recovery of original iron at 91 per cent is very satisfactory. The mining costs of low grade ores usually demand a high percentage of recovery in subsequent concentration, and in this respect the wet process is nearly always superior to the dry process.

The crude ore, broken to 1" in the Blake crusher, was fed to the Hardinge ball mill, the discharge from the latter going direct to the separators.

A sieve test of the ball mill discharge showed the pulp to be of the following mechanical condition:—

Sieve.	Per cent of total.	Cumulative per cent.
+ 30 − 20	0·098	
+ 40 − 30	0·164	0·262
+ 50 − 40	0·197	1·459
+ 60 − 50	1·885	3·344
+ 70 − 60	3·442	6·786
+ 80 − 70	2.705	9·491
+ 90 − 80	4·705	14·196
+100 − 90	7·344	21·540
+120 − 100	6·803	28·343
+150 − 120	7·443	35·786
+200 − 150	13·803	49·589
−200	50·410	

Weight of crude ore fed to separators	3,540	pounds.
" concentrate recovered	1,754	"
" tailing (by difference)	1,786	"
Per cent of concentrate recovered	49·54	
Ratio of crude ore to concentrate recovered	2·02	

Analyses of Crude Ore, Concentrate, and Tailing.

——	Crude.	Concentrate.	Tailing.
Fe	36·5	67·4	4·5
Insoluble matter	35·37	5·87	
P	0·026	0·007	
S	0·314	0·185	
CaO	5·68		
MgO	0·30		

Calculation of saving, from the above analyses:—

$\frac{67 \cdot 4 - 4 \cdot 5}{36 \cdot 5 - 4 \cdot 5} = 1 \cdot 96$ units of crude required per unit of concentrate,

or $\frac{100}{1 \cdot 96} = 51 \cdot 02$ per cent of concentrate recovered.

and $\frac{100 \times 67 \cdot 4}{36 \cdot 5 \times 1 \cdot 96} = 94 \cdot 2$ per cent of the iron in the crude saved in the concentrate.

Calculation of iron saved, from actual weights and analyses:—

$\frac{1754 \times 67 \cdot 4 \times 100}{3540 \times 36 \cdot 5} = 91 \cdot 4$ per cent of the iron in the crude saved in the concentrate.

Gross tons of concentrate made per ton of crude = 0·49.

TEST No. 12.

Childs Ore.

This ore is a granular, friable magnetite, containing calcite, pyroxene, chlorite, etc. Although the ore is comparatively soft, the gangue minerals are so intimately associated with the magnetite that fine crushing is necessary to effect a satisfactory separation of the magnetite from the gangue.

The results of this test show that a high grade concentrate may be produced without trouble from the low grade raw material, with a recovery of over 90 per cent of the original iron. The briquetted concentrate would be of special value on account of its extremely low phosphorus content.

The crude ore, broken to 1″ in the Blake crusher, was fed to the Hardinge ball mill, the discharge from the latter going direct to the separators.

A sieve test of the ball mill discharge showed the pulp to be of the following mechanical condition:—

Sieve.	Per cent of total.	Cumulative per cent.
+ 30 − 20	0·24	
+ 40 − 30	1·40	1·64
+ 50 − 40	3·70	5·34
+ 60 − 50	3·94	9·28
+ 70 − 60	6·64	15·92
+ 80 − 70	2·04	17·96
+ 90 − 80	7·90	25·86
+100 − 90	6·70	32·56
+120 −100	6·64	39·20
+150 −120	7·96	47·16
+200 −150	15·40	62·56
−200	37·44	
	100·00	

Weight of crude ore fed to separators	4,230	pounds.
" concentrate recovered	2,056	"
" tailing (by difference)	1,174	"
Per cent of concentrate recovered		48·6
Ratio of crude ore to concentrate recovered		2·05

Analyses of Crude Ore, Concentrate, and Tailing.

—	Crude.	Concentrate	Tails.
Fe	35·0	66·4	5·7
Insoluble matter	36·8	6·09	
P	0·083	0·016	
S	0·045	0·022	
CaO	5·83		
MgO	0·41		

Calculation of saving, from the above analyses :—

$\frac{66 \cdot 4 - 5 \cdot 7}{35 \cdot 0 - 5 \cdot 7} = 2 \cdot 07$ units of crude required per unit of concentrate.

or $\frac{100}{2 \cdot 07} = 48 \cdot 3$ per cent of concentrate recovered.

and $\frac{100 \times 66 \cdot 4}{35 \times 2 \cdot 07} = 91 \cdot 6$ per cent of the iron in the crude saved in the concentrate.

Calculation of iron saved from actual weights and analyses :—

$\frac{2056 \times 66 \cdot 4 \times 100}{4230 \times 35 \cdot 0} = 92 \cdot 2$ per cent of the iron in the crude saved in the concentrate.

Gross tons of concentrate recovered per ton of crude = 0·48.

TEST No. 13.

Experiments in Magnetic Separation with a Titaniferous Magnetite. From Rivière des Rapides, Seven Islands Bay, Que.

This ore is a typical example of the highly titaniferous magnetites that are found in several localities on the north shore of the river and gulf of St. Lawrence.

The ore possesses a somewhat compact, coarsely crystalline structure. The colour is iron black; very little, if any, of the bluish colour characteristic of many titaniferous magnetites, is noticeable. Only small quantities of gangue minerals are present, although both phosphorus and sulphur occur in appreciable quantities.

The problem was to experiment for the production of a magnetic iron concentrate, low in titanic acid.

The ore was first broken to 1″ in the Blake crusher, and then ground in the Hardinge conical ball mill, the discharge from the ball mill going direct to the Gröndal separators.

Results of this first concentration are as follows:—

—	Crude ore.	Concentrate	Tailing.
Fe (soluble)	41·2	55·28	28·01
TiO_2	25·6	19·8	35·26
SiO_2	9·36	0·66	
P	0·21	0·02	
S	0·71	0·443	

Weight of crude ore fed to separators	2,760	pounds
" concentrate recovered	1,458	"
" tailing by difference	1,302	"

and $\frac{2760}{1458} = 1 \cdot 89$ units of crude required per unit of concentrate.

also $\frac{100}{1 \cdot 89} = 52 \cdot 91$ per cent of first concentrate made from crude.

Sieve Test with Analyses of Crude Ore.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid, per cent of total.	Cumulative per cent of titanic acid.
− 20 + 30	0·17	....	30·2	0·124	....	16·43	0·109	....
− 30 + 40	0·72	0·89	23·7	0·414	0·538	13·21	0·373	0·482
− 40 + 50	1·45	2·34	25·4	0·893	1·431	14·14	0·802	1·284
− 50 + 60	1·28	3·62	24·9	0·773	2·204	13·93	0·697	1·981
− 60 + 70	3·43	7·05	34·0	2·829	5·033	20·34	2·727	4·708
− 70 + 80	0·31	7·36	35·9	0·276	5·303	22·4	0·271	4·979
− 80 + 90	4·66	12·02	35·7	4·036	9·339	23·32	4·249	9·228
− 90 +100	3·09	15·11	37·8	2·833	12·172	24·58	2·969	12·197
− 100 +120	7·12	22·23	40·8	7·047	19·219	24·46	6·809	19·006
− 120 +150	6·95	29·17	42·5	7·166	26·385	24·92	6·771	25·777
− 150 +200	16·17	45·35	43·0	16·868	43·253	25·48	16·108	41·885
−200	54·65	....	42·8	56·745	....	27·20	58·115	....
Totals and averages..	....	100·00	41·2	....	99·998	25·6	....	100·000

Sieve Test with Analyses of 1st Concentrate.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid, per cent of iron.	Cumulative per cent of titanic acid.
− 20 + 30	0·075	....	52·5	0·071	....	17·0	0·064	....
− 30 + 40	0·126	0·201	55·0	0·125	0·196	16·36	0·104	0·168
− 40 + 50	1·060	1·261	54·6	1·046	1·242	17·30	0·926	1·094
− 50 + 60	2·095	3·356	54·9	2·080	3·322	15·12	1·597	2·691
− 60 + 70	3·030	6·386	54·9	3·008	6·330	15·80	2·416	5·107
− 70 + 80	4·039	10·425	55·40	4·047	10·377	19·80	4·035	9·142
− 80 + 90	6·513	16·938	54·20	6·385	16·762	19·30	6·340	15·482
− 90 +100	6·009	22·947	55·70	6·054	22·816	17·60	5·335	20·817
− 100 +120	8·255	31·202	60·10	8·974	31·790	18·86	7·833	28·650
− 120 +150	8·533	39·735	57·80	8·921	40·711	18·86	8·097	36·747
− 150 +200	17·041	56·776	56·40	17·384	58·095	22·86	19·611	56·358
−200	43·221	......	53·60	41·903	....	29·00	43·634	....
Totals and averages..	....	99·997	55·28	....	99·998	19·8	....	99·992

Sieve Test with Analyses of 1st Tailing.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron per cent.	Distribution of iron: Iron, per cent of total.	Distribution of iron: Cumulative per cent of iron.	Titanic acid, per cent.	Distribution of titanic acid: Titanic acid, per cent of total.	Distribution of titanic acid: Cumulative per cent of titanic acid.
− 20 + 30	0·126	....	7·00	0·031	....	2·00	0·007	....
− 30 + 40	0·177	0·303	8·40	0·052	0·083	3·47	0·017	0·024
− 40 + 50	0·507	0·810	9·50	0·172	0·255	6·79	0·097	0·121
− 50 + 60	1·140	1·950	12·30	0·500	0·755	14·29	0·462	0·583
− 60 + 70	2·584	4·534	16·10	1·482	2·237	21·86	1·602	2·185
− 70 + 80	1·317	5·851	20·10	0·943	3·180	27·00	1·008	3·193
− 80 + 90	3·927	9·778	21·60	3·024	6·204	27·00	3·177	6·370
− 90 +100	3·623	13·401	22·00	2·841	9·045	31·86	3·273	9·643
− 100 +120	4·940	18·341	24·50	4·313	13·358	33·72	4·724	14·367
− 120 +150	5·447	23·788	24·20	4·698	18·056	35·00	5·406	19·773
− 150 +200	13·430	37·218	26·30	12·587	30·643	35·72	13·604	33·377
−200	62·782	....	31·00	69·357	....	37·42	66·622	....
Totals and averages....	....	100·00	28·01	....	100·00	35·26	....	99·999

The redistribution of the iron and titanic acid in the crude as effected by this first concentration is as follows:—

—	Iron, per cent of total.	Titanic acid, per cent of total.
Concentrate..................	66·7	38·5
Tailing..................	31·3	61·5
	100·0	100·0

The first separation has, therefore, divided the crude into two almost equal portions of concentrate and tailing. The iron has been concentrated to some extent with a rather low recovery, but elimination of titanic acid has not been satisfactory.

Sieve tests with analyses of the crude, concentrate, and tailing, given in the accompanying table, indicate that very fine grinding is somewhat favourable for the elimination of titanic acid. In the crude 58·1 per cent of the total TiO_2 is found in particles finer than 200 mesh, whereas the first concentrate and tailing contained 43·6 and 66·6 per cent of their total TiO_2 content in 200 mesh material.

The first concentrate was, therefore, re-ground and re-separated, with the following result:—

—	First concentrate re-ground.	Second concentrate.	Second tailing.
Fe..................	55·28	57·35	40·1
TiO_2..................	19·80	16·9	48·34
SiC_2..................	0·66	0·2	
P..................	0·02	0·010	
S..................	0·443	0·390	

Sieve Test with Analyses of 2nd Concentrate.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid, per cent of total.	Cumulative per cent of titanic acid.
− 50 + 60	0·201	....	58·90	0·206	......	13·31	0·158	....
− 60 + 70	1·267	1·468	57·70	1·275	1·481	14·29	1·070	1·228
− 70 + 80	0·946	2·414	57·50	0·948	2·429	15·22	0·850	2·078
− 80 + 90	2·655	5·069	58·50	2·708	5·137	15·03	2·354	4·432
− 90 + 100	2·756	7·825	59·90	2·879	8·016	16·58	2·825	7·257
− 100 + 120	3·742	11·567	57·30	3·982	11·998	16·58	3·907	11·164
− 120 + 150	4·466	16·033	56·90	4·431	16·429	16·58	4·348	15·512
− 150 + 200	16·536	32·569	56·60	16·319	32·748	17·14	16·497	32·009
− 200	67·431	.....	57·20	67·252	.	17·14	67·991	....
Totals and averages..	....	100·00	57·35	.....	100·00	16·9	....	100·00

Sieve Test with Analyses of 2nd Tailing.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid, per cent of total.	Cumulative per cent of titanic acid.
50 + 60	0·38	....	34·60	0·328	..	20·58	0·162	....
60 + 70	0·41	0·79	36·00	0·368	0·696	29·82	0·253	0·415
70 + 80	0·19	0·98	35·60	0·169	0·865	33·92	0·133	0·548
80 + 90	1·23	2·21	34·30	1·052	1·917	46·12	1·173	1·721
− 90 + 100	1·14	3·35	39·00	1·109	3·026	40·24	1·010	2·731
100 + 120	4·85	8·20	39·90	4·826	7·852	48·78	4·895	7·626
− 120 + 150	6·38	14·58	38·20	6·078	13·930	48·78	6·440	12·066
− 150 + 200	16·62	31·20	38·80	16·083	30·013	47·56	16·487	30·553
− 200	68·80	.	40·70	69·986	....	48·78	69·446	....
Totals and averages..	....	100·00	40·1	......	99·999	48·34	....	99·999

Weight of first concentrate ted to separators.......................... .... 1,451 pounds.
" second concentrate recovered..... .... 1,248 "

Weight of tailing, by difference..................... 203 "

and $\frac{1451}{1248}$ = 1·16 units of first concentrate required per unit of second concentrate.

also $\frac{100}{1\cdot 16}$ = 86·2 per cent of second concentrate recovered from first concentrate.

The re-distribution of the iron and titanic acid in the first concentrate as effected by the second concentration is as follows:—

—	Iron, per cent of total in first concentrate.	Titanic acid, per cent of total in first concentrate.
Concentrate	92·64	68·25
Tailing	7·36	31·75
	100·00	100·00

The second separation, while reducing titanic acid from 19·8 to 16·9 per cent, has resulted in the retention of the major portion of the titanic acid in the concentrate, allowing only 31·75 per cent to escape with the tailing.

Sieve tests, with analyses of the second concentrate and second tailing, are given in the subjoined table. These tests simply illustrate the homogeneity of the material, and do not throw much light on the manner in which TiO_2 may be depressed.

The results of the first and second separations have shown that it is impossible to effect a substantial reduction of titanic acid when the separators are operated under normal conditions of magnetic field strength.

It was decided, therefore, to re-grind the second concentrate, and then re-separate with the magnetic fields of the separators adjusted to one-half full strength.

Results for the third and final test are as follows:—

—	Second concentrate, re-ground.	Third concentrate.	Third tailing.
Fe	57·35	58·75	55·3
TiO_2	16·9	14·85	16·33
SiO_2	0·2		
P	0·01		
S	0·39		

Weight of second concentrate fed to separators	1,246	pounds.
" third concentrate recovered	475	"
Weight of tailing, by difference	771	"

and $\frac{1246}{475}$ = 2·62 units of second concentrate required per unit of third concentrate.

also $\frac{100}{2·62}$ = 38·16 per cent of third concentrate recovered from second concentrate.

The redistribution of the iron and titanic acid in the second concentrate, as effected by the third concentration, is as follows:—

—	Iron, per cent of total in second concentrate.	Titanic acid, per cent of total in second concentrate.
Concentrate	39·56	35·9
Tailing	60·44	64·1
	100·00	100·00

The third separation at much reduced amperage has resulted in a concentrate and tailing very similar in iron and titanic acid content.

The concentrate is a little higher in iron and lower in titanic acid than the tailing, but the difference is not marked, and the two products might well represent each other for all practical purposes.

Screen Test with Analyses of 3rd Concentrate.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid per cent of total.	Cumulative per cent of titanic acid.
70 + 80	0·76	....	61·6	0·796	....	10·16	0·518	....
− 80 + 90	1·73	2·49	59·5	1·752	2·548	12·78	1·488	2·006
− 90 + 100	1·57	4·06	60·7	1·622	4·170	14·23	1·501	3·507
− 100 + 120	2·54	6·60	58·9	2·546	6·716	13·77	2·357	5·864
− 120 + 150	4·27	10·87	58·6	4·259	10·975	13·44	3·865	9·729
− 150 + 200	14·11	24·98	58·1	13·951	24·926	14·23	13·516	23·245
− 200	75·01	....	58·8	75·074	....	15·20	76·754	....
Totals and averages..	....	99·99	58·75	....	100·000	14·85	....	99·999

Sieve Test with Analyses of 3rd Tailing.

Screen.	Per cent of total weight.	Cumulative per cent.	Iron, per cent.	Distribution of iron.		Titanic acid, per cent.	Distribution of titanic acid.	
				Iron, per cent of total.	Cumulative per cent of iron.		Titanic acid per cent of total.	Cumulative per cent of titanic acid.
− 70 + 80	0·78	....	54·7	0·077	....	12·78	0·599	....
− 80 + 90	2·34	3·12	56·9	2·406	2·483	13·44	1·888	2·487
− 90 + 100	2·21	5·33	57·7	2·304	4·787	13·77	1·824	4·311
− 100 + 120	1·90	7·23	56·1	1·926	6·713	14·23	1·623	5·934
− 120 + 150	4·22	11·45	56·4	4·302	11·015	15·41	3·909	9·843
− 150 + 200	15·15	26·60	55·6	15·223	26·238	16·07	14·636	24·479
− 200	73·40	....	55·6	73·757	....	17·11	75·520	....
Totals and averages..	....	100·00	55·3	....	99·99	16·63	....	99·999

The units of crude required, and the percentage of final concentrate are, therefore:—

$1·89 \times 1·16 \times 2·62 = 5·74$ units of crude required per unit of third concentrate,

and $\frac{100}{5·74} = 17·4$ per cent of third concentrate recovered from the crude ore.

The final redistribution of the iron and titanic acid in the crude, as effected by the three separations, is as follows:—

—	Iron, per cent of total.	Titanic acid, per cent of total.
Final concentrate	25·17	9·43
Final tailing	74·82	90·56

With a recovery of only 25 per cent of the original iron, it has been possible to eliminate over 90 per cent of the titanic acid. This would indicate that the titanic acid is so intimately associated with the iron that a magnetic separation of the two is not feasible. The ore evidently does not contain any appreciable amount of magnetite, and although its composition is not identical with true ilmenite, yet it approaches the latter so closely in chemical and physical characteristics, that it may be regarded as such, as far as the separation of its iron and titanic acid contents is concerned.

While the above magnetic separation tests have failed to produce a relatively low titanic acid iron concentrate, they show that a very pure iron-titanium concentrate may be made from the crude, and it is suggested that this material would probably find a market with the manufacturers of ferro-titanium alloys, and also with the manufacturers of special composition carbons for arc-lights.

TEST No. 14.

Magnetic Separation Tests with Low Grade Magnetite, from Carter, West Virginia, U.S.A.

The sample submitted for testing was much decomposed, hence its composition is difficult to determine, without making elaborate analyses.

Briefly described, the ore consists of kaolinized material, evidently the decomposition product of feldspar. When wetted, the ore exhibits the characteristic odour of damp clay. Throughout the gangue magnetite occurs in scattered grains and tiny veinlets.

A magnetic separation test on 1,107 pounds of this ore was carried out with the Gröndal magnetic separators. Results are as follows:—

The crude was crushed in a Blake crusher to 1″ and then fed to a 4′-6″ Hardinge conical ball mill. The mechanical condition of the ball mill discharged pulp is illustrated by the following screen analysis:—

Screen.	Per cent material.	Cumulative Per cent.
+ 30 − 20	0·141	
+ 40 − 30	0·707	0·848
+ 50 − 40	1·616	2·464
+ 60 − 50	3·172	5·636
+ 70 − 60	4·242	9·878
+ 80 − 70	3·737	13·615
+ 90 − 80	5·798	19·413
+100 − 90	4·767	24·180
+120 − 100	5·374	29·554
+150 − 120	6·202	35·756
+200 − 150	9·900	45·656
−200	54·343	
Total	99·999	

From the ball mill the pulp was discharged direct to the magnetic separators.

Weight of crude fed to separators	1,107	pounds.
" 1st concentrate recovered	18	"
" 1st tailing recovered	270	"
" slime, loss (by subtraction)	819	"
Total	1,107	"

Analyses of Crude, 1st Concentrate, and 1st Tailing.

—	Crude ore.	1st Concentrate.	1st Tailing.
Fe	22·3	66·3	20·7
SiO_2	22·5	8·44	
TiO_2	14·44	3·7	12·0
P	5·61	0·163	
S		Trace	

The first tailing was then re-concentrated as follows:—

Weight of 1st tailing fed to separators	265	pounds.
" 2nd concentrate recovered	19	"
" 2nd tailing recovered	192	"
" slime, loss (by subtraction)	54	"
Total	265	"

Analyses of 2nd Concentrate and 2nd Tailing.

—	2nd Concentrate.	2nd Tailing.
Fe	63·1	24·8
SiO_2	7·56	
TiO_2	3·57	18·0
P	0·168	
S	Trace	

The second tailing was then re-concentrated as follows:—

Weight of 2nd tailing fed to separators	190	pounds.
" 3rd concentrate recovered	1·5	"
" 3rd tailing recovered	154·0	"
" slime, loss (by subtraction)	34·5	"
Total	190	"

Analyses of 3rd Concentrate and 3rd Tailing.

—	3rd Concentrate.	3rd Tailing.
Fe	60·00	22·5
SiO_2	....	
TiO_2	2·84	16·5
P	0·161	
S	Trace	

Recovery of iron :—

$$\text{Total iron in original ore} = \frac{1107 \times 22{\cdot}3}{100} = 246{\cdot}86 \text{ pounds.}$$

Concentrate.	Pounds weight.	Iron, per cent.	Iron, pounds.	Iron, per cent of total.
No. 1	18	66·3	11·93	4·83
No. 2	19	63·1	11·99	4·85
No. 3	1·5	60·0	0·90	0·37
	38·5	......	24·82	10·05

Iron saved in total concentrate	10·05 per cent.
" left in final tailing	14·03 "
" lost in slime	75·91 "
Total	99·99 "

$$\text{Units of crude ore per unit of total concentrate} = \frac{1107}{38 \cdot 5} = 28 \cdot 75$$

$$\text{Per cent of total concentrate recovered} = \frac{100}{28 \cdot 75} = 3 \cdot 47$$

The large amount of iron lost in slime as well as the amount left in final tailing indicates that the ore is feebly magnetic and will not respond to treatment with separators of the Gröndal type. It may be possible to effect a higher recovery of iron with dry separators of the high tension type, but the concentrate made by such machines would not be as fine a grade as that produced with wet separators like the Gröndal.

The ore is considered to be of too low grade and too feebly magnetic to render its exploitation of value commercially.

II.

INVESTIGATION OF THE MAGNETIC IRON SANDS AT NATASHKWAN, QUEBEC.

The preliminary field work accomplished in the summer of 1911, with an ordinary post hole auger, indicated that approximately half a million tons of magnetic concentrate could be recovered from an area of 169 acres, to a depth of 16 feet.

This amount of magnetite, although in itself too small to be regarded seriously as a valuable source of iron ore, was considered sufficient to warrant a detailed examination for purposes of a more accurate estimation of available tonnage.

Accordingly a 4" standard Empire drill was purchased from the New York Engineering Company and field work was commenced on June 18 of last year.

As the first seasons work had afforded some valuable information regarding the distribution of the magnetic black sand throughout a certain area, it was decided to re-bore this area with the Empire drill, thus checking the results of the first season and establishing if possible a standard and reliable method of work for future operations. This was considered of utmost importance, as any estimation of tonnage might be misleading unless obtained by methods that would represent within reasonable accuracy the actual condition of the black sand distribution.

Preliminary work had established the fact that the magnetic sand was of intermittent and irregular occurrence, consisting of bands or layers extremely variable in length and depth. Hence the taking of accurate samples and the subsequent estimation of tonnage are rather difficult matters.

Sampling with the post hole auger has two very great disadvantages: (1) the bore-hole being without casing renders the taking of accurate samples impossible inasmuch as the core from a few feet of depth would when lifted be salted by brushing against the sides of the hole; (2) when the level of the ground water is reached the auger will not lift the soft core, neither will the sides of the hole stand without caving.

The Empire drill was selected because it afforded means of taking accurate samples to any desired depth irrespective of the watery condition of the ground; at the same time being of light portable construction its transportation from place to place is not difficult.

The drill had been designed primarily for sampling alluvial deposits, principally gold placers, although it may be used in almost any kind of ground excepting solid rock.

Briefly described it consists of a pipe casing with a toothed cutting shoe on the bottom and a platform on the top. The casing is rotated by hand or horse-power, while the operators standing on the platform alternately raise and lower a string of drill rods inside the casing; the drilling and pumping tools being attached to the lower end of the rods.

The casing being rotated continuously and thus kept loose is sunk by the combined weight of itself, the men on the platform, and by the jarring effect of the tool striking at the bottom of the hole. As the casing sinks it accumulates, a core of the ground being penetrated, and the churning of the drill tool forces this material into the pump. When filled the pump is removed from the casing and its contents emptied and sampled.

While the full pump is being emptied of its contents, a second pump is attached to the rods, lowered into the casing, and drilling operations continued. These operations take place alternately and repeatedly, fresh lengths of casing and drill rods being added as required until the hole has been sunk to the desired depth.

When sufficient depth has been attained the drill rods and platform are removed and the casing pulled from the hole by leverage. If the ground is at all tight the casing should be rotated while being pulled, although experience in drilling the loose sands at Natashkwan demonstrated that rotation during pulling was unnecessary most of the time.

The outfit is then transported to the next station, set up, and drilling continued. If the ground is dry, water must be poured into the casing in order that the pump will work, the amount of water required depending on the nature of the ground.

The area to be sampled was surveyed into squares of 500 feet to the side, the corners and centres of each square being staked and numbered for location of bore-holes. The number and distribution of the holes required to yield accurate and essential data is a difficult matter of determination depending on the characteristics peculiar to the deposit under examination. In the present case it was thought that the irregular occurrence of the black sand layers throughout the beaches and dunes would render the spacing of bore-holes, for accurate samples, rather uncertain. Regular spacing of holes was, of course, essential, and as the only regularity observed in the occurrence of the black sand consisted in a more or less parallel position with respect to the sea-shore, it was decided to block out the ground with lines parallel, and at right angles to the beach.

Five holes were put down in each square, one at each corner and one at the centre. These holes would, it was considered, yield average samples representative of the square, and the subsequent checking of two squares, some distance apart, by sinking eight additional holes in each, proved this assumption to be correct.

Forty squares were laid out, staked, and drilled as described above. The area covered was 184 acres, and 105 holes were sunk to a depth of about 30 feet.

In none of the holes was black sand found below a depth of 30 feet, and the majority of the holes yielded nothing of value below 25 feet.

A detailed and illustrated report of this work will be prepared and published at a later date. This report will contain the tonnage estimates, also the results of further experiments in the magnetic concentration of the sand.

III.

THE NEW ORE DRESSING AND METALLURGICAL LABORATORIES.

In June, 1912, work was commenced on the construction of the addition to the Fuel Testing Station, which contains the new and enlarged laboratories for ore dressing and metallurgical investigation.

Building operations continued until the latter end of November, hence it was not until December that the installation of machinery could be started. This delay has affected the date set for completion of the laboratory, but it is expected that all apparatus will be ready for operation by the end of June, 1913.

In addition to the ore dressing laboratories, the new building contains general chemical, gas analysis, and furnace laboratories, with the necessary balance, stores, and office rooms. A machine shop has also been provided for general repair work, and the making of new apparatus.

The ore dressing laboratory consists of one large room, approximately 52 feet square and one and a half stories high. When equipped, it will contain the following machinery and apparatus:—

CRUSHING AND SCREENING.

One Hadfield and Jacks, 12″ × 8″, Blake crusher.
One Allis-Chalmers, 24″ × 14″, style "C," crushing rolls.
One Hardinge, 4′-6″, conical mill.
One Ferraris, 6 ft. screen, for coarse sizing and scalping.
One No. 3 Keedy ore sizer, for fine sizing.

SAMPLING, ETC.

Sampling is provided for by two standard Vezin machines, placed in favourable positions to cut out preliminary samples of coarse materials. The fine material will be sampled by an eight unit system of the Flood automatic sampler. Provision has also been made for sampling by hand, using the Jones riffled samplers.

All water lines serving standard apparatus, will be equipped with Keystone water meters to enable the keeping of an accurate record of water consumption.

AMALGAMATION AND CONCENTRATION.

One, Allis-Chalmers 5 stamp battery with 1,250 pound stamps, equipped with a 10 ft. tilting amalgamating table followed by a Pierce amalgamator. The mortar of this mill may be, if so desired, arranged for inside amalgamation.

Six 8 ft. Callow tanks.
One duplex standard Callow screen.
Two Richards pulsator classifiers, launder type.
One Richards pulsator, two compartment jig.
One Overstrom sand table.
One Deister slime table.
One tandem unit Gröndal magnetic separator for wet separation of strongly magnetic minerals.
One Gröndal magnetic cobber, with dust collector for dry separation of strongly magnetic minerals.

One Ullrich four pole magnetic separator for either dry or wet separation of weakly magnetic minerals.

One Huff electrostatic unit, comprising a standard generator and two laboratory type separators.

Small scale apparatus.

One 2″ × 6″ Sturtevant laboratory crusher.

One 8″ × 5″ Sturtevant laboratory rolls.

One Sturtevant laboratory screen.

One Braun planitary pulverizer.

One gyratory screen frame (Hoover type) for making dry screen analysis with nested screens.

One six jar, Abbe sample mill.

One combination Richards pulsator jig and classifier, laboratory type.

One 24″ laboratory Wilfley table.

One laboratory Gröndal magnetic separator.

One laboratory cyanide equipment comprising a Parrel agitator and air pump with the necessary solution, zinc and sump tanks.

Two laboratory filter presses.

One complete set of I.M.M. standard screens.

One complete set of Tyler standard screens, after Rittinger scale.

The installation of an experimental roasting and sintering outfit will be undertaken some time during the coming year.

Power for the above laboratory will be supplied by a 40 H.P. D.C. motor supplied with energy from the generator connected with the gas engine of the Fuel Testing plant.

When completed it is expected that the laboratory will possess sufficient latitude to cope with the more general problems in ore dressing that are from time to time presented to the Department.

Samples of Canadian ores will be tested free of charge, providing that they are delivered at the laboratory carriage paid.

For particulars regarding the arrangement of tests, application should be made to the Director of Mines.

IV.

APPENDIX.

REPORT ON THE PARKER-LANIUS PROCESS OF EXTRACTING GOLD FROM FREE MILLING AND REFRACTORY ORES.

This test was undertaken at the instance of Messrs. Parker-Lanius and their associates, who desired to demonstrate the value or efficiency of their process to the satisfaction of Mines Branch officials.

Messrs. Parker and Lanius of New York city, U.S.A., claim that by their secret process they are enabled to extract over 90 per cent of gold from any ore of that metal, either free milling or refractory.

Their process consists of treating an ordinary copper plate with an *acid solution* and metallic mercury to form an amalgam. The gold is caught by allowing the finely ground ore with sufficient quantity of water to wash over the plate, and the amalgam, owing to peculiar and special properties imparted to it by the acid solution, *attracts* and holds in solution the particles of precious metal.

This method or process, so it is claimed, is much superior to the ordinary well known methods of gold amalgamation in stamp battery practice.

The tests to be described were carried out in the ore testing laboratory of the Mines Branch, Department of Mines, at Ottawa.

Ore Used in Testing.—Gold ore from the Dome mine, Porcupine, Ontario.

Character of Ore.—Quartz and quartz schist, containing comparatively small amount of sulphides, chiefly iron pyrite. No free gold is visible, but numerous colours may be obtained by panning the pulp. The ore is what is generally known as partially free milling.

Quantity of Ore Used.—Fifteen pounds in each test.

Mechanical Condition of Ore Used.—All the ore was pulverized to pass a 100 mesh screen.

Sampling.—After crushing and pulverizing, the pulp was thoroughly mixed and then sampled by means of a Jones laboratory sampler. Three samples were taken:—

(1) For Mines Branch assay,
(2) For Parker-Lanius assay,
(3) For umpire assay, if so desired.

After sampling, the pulp was divided into two portions of 15 pounds each. One portion was used by the Mines Branch in ordinary amalgamation test; the second was used by Messrs. Parker and Lanius in their special process.

Apparatus.—Messrs. Parker and Lanius brought with them from New York two copper plates, each 5 feet long, 30 inches wide, and about 3/32 of an inch thick. These plates were mounted on a table with a slope of 1½ inches to the foot. The plates were placed end to end, slightly overlapping. There was no drop between the plates.

The Mines Branch used one side of the plates for the first test. Messrs. Parker and Lanius used the other side of the plates for the second test.

FIRST TEST: BY MINES BRANCH.

The plates were first rubbed down to bright copper with sea sand and potassium cyanide solution, after which they were amalgamated with metallic mercury in the usual manner. Two ounces of silver were then applied in the form of silver amalgam; this was worked in vigorously over the whole surface of the two plates. They were then allowed to stand overnight under a small stream of water, and in the morning were rubbed up and softened with the addition of a little more metallic mercury.

The pulverized ore (15 pounds) was then run over the plates with sufficient water from a V shaped copper feed box. This feed box presented the ore to the upper end of the plates through a series of small holes, about 1/16 of an inch in diameter.

The pulp in its passage over the plates was not rubbed or assisted in any manner likely to promote amalgamation. A stream of water was, however, used to wash and keep moving any accumulations of pulp that were caught on the uneven and irregular surface of the plates. The test was completed in 53 minutes.

All tailing and tailing water were caught in tubs. Material in suspension was settled by the addition of two pounds of lime. Clear water was then siphoned off and the tailing collected, dried, weighed, and sampled.

The weight of the dry tailing, plus the weight of the added lime, was found to be approximately 16·75 pounds.

Three samples of the tailing were taken by the Jones sampler:—

(1) For Mines Branch assay,
(2) For Messrs. Parker and Lanius assay,
(3) For umpire assay, if so desired.

The results of this test are as follows:—

Original ore. Gold, ounces per ton.	Tailing. Gold, ounces per ton.	Amalgamated by diff. Gold, ounces per ton.	Recovery. Per cent.
1·48	0·95	0·53	35·7

SECOND TEST: BY MESSRS. PARKER AND LANIUS.

Before proceeding with their test, Mr. Parker stated that they desired to use the same side of the plate for their test, as had been used by the Mines Branch in the first test. This was objected to, however, as they had claimed that their process did not require any special preparation of the plates. To quote from their published prospectus: "No expensive, silver-plated plates are used. *By treatment, ordinary copper plates are put into condition to receive the quicksilver*, which, having also been subjected to treatment, is applied to the copper in the usual way by splashing. *No rubbing or grinding in is required*, as the quicksilver at once spreads over the surface of the plates and is ready for the pulp. This application requires but a few moments."

It would appear, therefore, that a rigid test of their process requires that they should start with clean copper plates. This condition was insisted upon, although Mr. Parker characterized it as unfair and prejudicial.

Messrs. Parker and Lanius then proceeded to prepare the reverse side of the plates for their test.

After a preliminary wash with potassium cyanide and clear water, they applied the acid solution and metallic mercury. About ten minutes were employed in making the plate ready.

The ore (15 pounds) was then run over the plates from the same V shaped feeder that had been used for the first test. While the pulp was flowing over the plate, Mr. Lanius used a small mop to brush the pulp across the plate and from side to side towards the end. The use of the mop was evidently to assist amalgamation by working the pulp against the surface of the plate. It need hardly be stated that this method of assisting amalgamation is unpractical and could not be successfully applied on a commercial scale.

All tailing and tailing water were collected in tubs and settled by the addition of two pounds of lime. The clear water was then siphoned off and the tailing collected, dried, weighed, and sampled.

The weight of the dry tailing, plus the weight of the added lime, was found to be 16·5 pounds.

Three samples of the tailing were taken by the Jones sampler:—

(1) For Mines Branch assay,
(2) For Parker-Lanius assay,
(3) For umpire assay, if required.

The results of this test are as follows:—

Original ore. Gold, ounces per ton.	Tailing. Gold, ounces per ton.	Amalgamated gold, by diff. ounces per ton.	Recovery. Per cent.
1·48	0·77	0·71	47·9

After the above tests were completed, Messrs. Parker and Lanius returned to New York. Before leaving, they were shown the figures representing the recovery of gold by their process, but they offered no explanation of the fact that they had failed to extract 50 per cent of the total amount of gold in the ore.

THIRD TEST, USING MORTAR AMALGAMATION: BY THE MINES BRANCH.

Subsequent to the departure of Messrs. Parker and Lanius, the Mines Branch made a third test on the Dome ore, by mortar amalgamation, to determine the maximum recovery of gold that may be extracted by mercury.

Four and a half pounds of the ore, ground to 100 mesh, were taken and mixed with sufficient quantity of water to form a thin paste. Mercury was then added to the extent of 117·5 grammes, by splashing through chamois leather, and the whole mass triturated in an iron mortar for 1¾ hours. The contents of the mortar were then washed into a gold pan and the amalgam recovered by panning. The tailing was settled by the addition of a small quantity of lime, clear water siphoned off, and the slime dried and sampled.

The amalgam was then treated with nitric acid for recovery of the amalgamated gold. The results of the test are as follows:—

4·5 pounds of ore amalgamated; gold content as per assay.	1·43 ounces per ton.
Gold recovered by amalgamation	67·7 milligrams.
equivalent to.	0·9673 ounces per ton.
Gold in tailing, by assay.	0·46 " "
Total	1·4273
Unaccounted for.	0·0027 ounces per ton.
Total	1·4300

The recovery by amalgamation was, therefore:—

$$\frac{0{\cdot}9673 \times 100}{1{\cdot}43} = 67{\cdot}63 \text{ per cent.}$$

The above tests have demonstrated that the claims put forward by Messrs. Parker and Lanius for their process have not been substantiated. They not only failed to make a recovery approaching 90 per cent of the gold from the samples submitted, but they also failed to make a recovery equivalent to the maximum recovery of free gold by mercury amalgamation.

THE BUILDING AND ORNAMENTAL STONES OF THE PROVINCE OF QUEBEC.

William Arthur Parks.

Pursuant to the instructions of the Director, I spent six weeks of the field season of 1912 in examining quarries in the Province of Quebec. As the region north of the St. Lawrence river had been worked during the summer of 1911, the operations of the present year were confined to the country south of the river.

I left Toronto for the field on June 2 and returned home on July 14.

The following brief account of the stone industry in Quebec is based on the field work of both 1911 and 1912. The types of stone which are actually being quarried for structural or ornamental purposes are as follows:—

Limestone
Sandstone
Granite
Black granite
Marble
Slate.

LIMESTONE.

Excellent limestone for building purposes is quarried at various centres, of which the following are the most important.

Hull.—Several operators are producing a large quantity of high grade building material from the Trenton strata at Hull. The product is largely used in Hull and Ottawa and is sometimes shipped to considerable distances.

Montreal.—Many operators are working on a large scale, and numerous others in a less extensive manner, in winning stone from the Trenton and Chazy strata in the neighbourhood of Montreal. In the immediate vicinity of the city, quarries are being worked at Mile End, Villeray, Maisonneuve, and on Nicolet and Iberville Avenues. The Bordeaux quarries are less extensively worked than formerly and the St. Laurent locality is not now in operation. The Caughnawaga quarries across the river are devoted entirely to the production of crushed stone.

On Ile Jesus, the Chazy limestones of Cap St. Martin and vicinity are being worked by a number of firms, and the Trenton rocks are being extensively exploited, more particularly at St. François de Salles and St. Vincent de Paul.

St. Marc des Carrières.—The building stone industry is being actively carried on at this point by Georges Chateauvert, by la Compagnie des Carrières, and by several other operators. Trenton limestone of excellent quality, in beds of suitable character for economic quarrying, assures the permanence of the industry at this old centre. The stone is in demand in Quebec and Montreal, and it has been shipped as far west as Toronto.

Joliette.—Several operators quarry a good quality of limestone at Joliette and at points immediately to the east of that town.

Roberval.—The Trenton limestones of Lake St. John yield a desirable product. The local demand is necessarily small and in consequence quarrying operations are intermittent only.

Quebec.—Thin-bedded limestone is quarried from the Trenton strata to the eastward of Quebec at Beauport, and at other points. Most of the output is crushed, but a small quantity is employed in the building of walls of a rough character.

St. Dominique.—A somewhat banded type of limestone is quarried at St. Dominique in Bagot county, and is used extensively in St. Hyacinthe and other places in the vicinity.

St. Johns.—Limestone quarries have been operated in the vicinity of St. Johns and Grande Ligne in St. Johns county. In former years a considerable amount of building stone was raised from these quarries, and, more recently, one in the vicinity of St. Johns was worked on a large scale for the production of crushed stone. At the time of my visit, none of these quarries were in operation.

Dudswell.—The thin-bedded Silurian strata which occur at Dudswell in Richmond county, yield excellent stone for the making of flags. The decline in the demand for this product, which has resulted from the almost universal use of cement, has seriously affected the industry; nevertheless, a small amount of flagging is quarried annually.

Montreal, Hull, and St. Marc des Carrières are to be regarded as the chief centres of the limestone industry. In the scale of production, in the quality of the stone, and in the geographical range of consumption, these points far surpass the other localities mentioned above.

SANDSTONE.

At the present time, this branch of the stone industry is not in a flourishing condition; furthermore, it is not likely that operations in sandstone will ever prove so extensive as in limestone, granite, and marble. The chief reason for this statement lies in the fact that sandstone, of the high grade required for monumental structures, is either not present in the Province, or occurs under conditions which are not favourable for exploitation.

Beauharnois.—The hard Potsdam sandstones of Beauharnois, which yield a product suitable for rock-face work, have been worked for many years. Operations have not been suspended entirely as a small annual output has continued to be produced up to the present time.

Stone of a similar nature at St. Jerome and at Papineauville on the Ottawa river, has not been exploited in many years.

Levis.—The old quarries in the Sillery formation near Levis, which produced much of the stone formerly employed to a large extent in Quebec, are now being worked by Dr. Desseault at St. Jean Chrysostome. The product is used for the construction of bridge piers on the Grand Trunk railway.

A similar stone is being excavated in large quantity near the northern approach to the new Quebec bridge by M. P. Davis of Ottawa. Incidentally some of this stone finds its way into structural use.

Bordeau.—On the north side of the Restigouche river, about opposite Campbellton, in New Brunswick, a considerable amount of rather coarse, olive-coloured sandstone was quarried for use in Campbellton, and in the construction of the Intercolonial railway. Mr. T. R. Busteed is at present engaged in reopening these old quarries.

Causapscal.—The sandstone of the interior of the Gaspé peninsula probably presents greater promise of future development than the other sandstones of the Province. Stone of good quality was obtained at several points along the line of the Intercolonial railway at the time of construction. None of these quarries are now in operation, but possibilities exist, more particularly, at Causapscal, Lac au Saumon, and Mataleck.

GRANITE.

The Province of Quebec is rich in granites of which the grain and colour are suitable for structural and monumental purposes. There is little doubt that, with

the increase of wealth and population, this class of stone will be employed in increasing amount. The more important localities at which granite is actually quarried are as follows:—

Stanstead.—The grey granites of Stanstead have been long and favourably known, and are filling a constantly increasing demand. Three types of stone, of which the first is the most important, occur in the vicinity. These types are Stanstead grey, Stanstead silvey grey, and a lighter somewhat coarser grey variety.

The following firms or individuals are actively engaged in quarrying:—

Stanstead Granite Quarries Company, Limited.
James Brodie.
Samuel B. Norton.
Russel Redicker.
Geo. S. Sommerville.
G. W. Moir.
Charles Haselton (Not now working).

Stanhope.—At Stanhope in Stanstead county, a number of quarries have been opened in a large granite mass near the International Boundary. The most important producer is the Frontier Granite Company of Stanhope.

Magoon Point.—At Magoon point on Lake Memphremagog, a coarse-grained greyish granite was quarried some years ago. The total output was insignificant, but the locality presents favourable conditions.

St. Sebastien.—Numerous granite quarries have been opened on Lake Megantic and along the east side of Little Megantic mountain. At the present time, the only one of these quarries in actual operation is that of Lacombe and D'Allaire about half way between St. Sebastien and St. Samuel. The product is a rather coarse-grained, greyish stone.

Rivière a Pierre.—At this point in Portneuf county, a coarse-grained and somewhat gneissoid granite, as well as a finer-grained type, is quarried by J. N. Perron, F. Voyer, and Dumas Frères. The product is used in heavy engineering works, for architectural purposes, and for paving blocks.

Roberval.—Auguste Bernier raises a coarse-grained granite from an exposure near Roberval on Lake St. John. The stone is used locally, and has also found a market at Quebec and other points.

St. Canut.—A granitoid gneiss, showing varying development of the laminated structure, has been quarried by Joseph Cyer and others near St. Canut in Two Mountains.

Staynerville.—An even-grained granite is extensively quarried near Staynerville in Argenteuil, by the Laurentian Granite Company and James Brodie. The former Company has a large plant and mill. The product is sold for building and monumental purposes as well as in the form of crushed stone and paving blocks.

Bedard.—Near this point in the township of Campbell, county of Ottawa, James Brodie and Son have recently opened quarries on a fine-grained, greyish and pinkish granite of good appearance and excellent formational structure. The product is shipped as dimension blocks and as paving stone.

BLACK GRANITE.

The so-called "black granite" which really comprises different varieties of dark, basic, igneous rocks, has been quarried for monumental purposes, for paving stones, and for building blocks from several of the eruptive mountains of the Eastern Townships. Among these may be mentioned Shefford mountain, Brome mountain, Yamaska mountain, and Mount Johnson. The last mentioned locality, in Iberville county, is

the only one from which any stone is now being shipped. Two companies are actively engaged—James Brodie and Son of Iberville and the Mount Johnson Quarry Company of Montreal. The product is shipped for monumental use, but some paving stone is produced incidentally.

MARBLE.

Extensive deposits of marble are known to occur in different parts of the Province. While the economic possibilities of many of these occurrences are entirely unproved, it is encouraging to note that the industry is far past the experimental stage in more than one locality.

Phillipsburg.—An extensive belt of grey and green clouded and mottled marble is quarried by the Missisquoi Marble Company at Phillipsburg in Missisquoi county. The Company has installed a modern quarrying plant and mill, and has been working on an extensive scale for some years. The product has been shipped to all parts of the Dominion: it enjoys a favourable reputation and is in increasing demand.[1]

South Stukely.—At South Stukely in Shefford county, the Dominion Marble Company of Montreal is operating on a belt of marble of handsome appearance. The stone presents numerous varieties, of which the more important are yellow, blue, and violet clouded, and green veined examples. A good quarrying plant is installed on the property but the product is shipped in blocks to the Company's mill at Montreal.

Portage du Fort.—Many years ago, quarrying operations were carried on in the belts of coarse-grained white and grey banded marbles of Portage du Fort on the Ottawa river. Mr. Wm. Dolley of Portage du Fort has recently opened new quarries at a promising point on one of the white belts.

Three Rivers.—A new company has begun operations for marble near this point; the quarry has not yet been visited but an inspection of the property will be made before the final report is prepared.

While the above localities represent the chief occurrences of marble which are now being exploited, it is to be remembered that numerous other localities present reasonable prospects of successful operation.

SLATE.

The slate industry has fallen far below the degree of prosperity it formerly enjoyed. Throughout the metamorphic region of the Eastern Townships, are numerous bands of slate concerning which it is somewhat hazardous to venture opinions. Many of these belts have been prospected with varying degrees of success, while many others have never been exploited. Of the numerous quarries which were formerly operated, only one—that at New Rockland—is now in operation.

On the line of the Transcontinental railway near Long lake in Temiscouata county, Messrs. Frazer and Davis of New Rockland have opened quarries in a promising band of blue-grey slate.

MISCELLANEOUS DECORATIVE MATERIALS.

The crystalline and metamorphic areas of Quebec contain many substances highly desirable for ornamental purposes, such as serpentine, verde antique, iridescent feldspars, garnet rock, etc. Little or no attempt has been made to prove the economic value of these deposits: for the present, therefore, they are to be regarded only as possible sources of supply.

---

[1] A preliminary description of the Missisquoi quarry and plant is given in Publication No. 100 of the Mines Branch, pp. 103-104

I.

WORK ON PYRITES AND COPPER.

Alfred W. G. Wilson.

The preparation and revision of the final manuscript of 'Report on Pyrites in Canada' occupied the writer for nearly the whole of the first half of this year. The report was completed at the end of June and is now in press; it is expected that it will be issued about the end of January in 1913. Since the report on pyrites was completed, there has been very little change in the pyrites situation in Canada. Ontario and Quebec are the only provinces in which there is any production. In Ontario one new property is being opened up in North Hastings; in both Ontario and Quebec there has been a small amount of additional prospecting for pyrites, but as yet no development work has followed. Several personal inquiries have been received during the year, chiefly from parties in the United States who are looking for Canadian pyrites. In the majority of cases these parties were desirous of obtaining developed properties. In each case they were furnished with the best information that was available.

Towards the end of May, the writer was required to lay aside his other work, in order to proceed to Nova Scotia to examine an area of Triassic rocks near Digby, for the purpose of investigating an alleged occurrence of coal. He left Ottawa on May 29 and returned to the office on June 7. The report of this investigation is attached to this summary report. On the return journey the iron mines at Bathurst, N.B., were visited to obtain some plates to accompany the report of Mr. E. Lindeman, on these mines.

On the completion of the report on pyrites, the writer resumed work on the monographs describing the copper mining and smelting industries of Canada. About one half of his time, during the last three years, has been spent in collecting information for this report. The greater portion of the writer's time during the winter months, has been requisitioned for other official duties. This field work for this report was almost completed last season. During the present year considerable progress has been made on the manuscript of the report. Towards the end of the year about two months were spent in further field work, for the purpose of revising the more important descriptive sections of the report, and bringing them up to date.

The mass of material available for this report is large and it has been found advisable to subdivide the monograph into two sections, one dealing with the mines, prospects, and mining methods, the other descriptive of the smelting industry. Each section will be complete in itself and the sections are to be issued separately. The frequency with which changes and additions to our smelting plants follow each other, makes it difficult to prepare a report that shall be accurate and fully up to date. The time that necessarily elapses between the completion of the field work and the publication of a report, is frequently sufficient for very radical changes to have taken place in the works described. The reports now in preparation will, however, represent the conditions existing at the close of the year 1912.

II.

REPORT ON MINERAL DEPOSITS IN THE VICINITY OF ST. MARY BAY, NOVA SCOTIA.

(Prepared at the request of C. Jameson, Esq., M.P., Digby, N.S.)

Dr. Eugene Haanel,
Director of Mines,
Ottawa.

Sir,—In accordance with your instructions, I went to St. Mary bay, Nova Scotia, to report on the alleged mineral deposits of that district. Also in accordance with your instructions, I called upon C. Jameson, Esq., M.P., at Digby, Nova Scotia, to ascertain the location of the places which Mr. Jameson wished to have examined.

Mr. Jameson placed at my disposal such information as he had, and was also kind enough to accompany me to the several localities in question. It may also be noted that, previous to this visit, I had spent two days in the district when investigating the copper deposits of Canada. On the present occasion, in addition to the places visited in company with Mr. Jameson, such other localities were visited as I deemed necessary to make myself acquainted with the local geological conditions.

As the result of my several examinations of the district, I beg to report that I do not consider the deposits of iron ores and of native copper, which are *at present known to occur in the vicinity of St. Mary bay, Nova Scotia,* to be of any commercial value. Nor do I know of the existence of any reason whatever to cause me to believe that coal-bearing strata occur in the district.

Before referring more in detail to the several economic minerals which occur, or which it was thought might occur, here, I wish to draw your attention to the fact that this region has been investigated geologically during the last seventy years by a score or more of geologists and engineers, including several officers of the Geological Survey. A complete and very detailed account of the geology of southwestern Nova Scotia, in which the geology of Digby county, and the probable occurrence of economic minerals in that vicinity are fully discussed, was published in 1898. (Report on the Geology of Southwest Nova Scotia, by Dr. L. W. Bailey, Geol. Survey publication No. 629.) This report is accompanied by a geological map of the district (Map No. 641.) No discoveries of any importance appear to have been made since Dr. Bailey's report was published.

Iron Ores.—For many years it has been known that iron-bearing minerals, in the form of hematite and magnetite, occur in the traps of North Mountain. These minerals usually occur in narrow veins in the rock. The width of the veins varies from less than 1 inch to 2 or 3, and possibly more, feet in width. Some of the veins exhibit comb structure and contain crystals of magnetite and quartz (including amethysts). Fragments of iron ores from veins of this character are very frequently found in the loose waste which overlies the bed-rock in many places, showing that there are many of these veins. The fragments are always small and often contain only a little iron, the balance being silica in the form of quartz. The particular veins which I visited on this occasion, in company with Mr. Jameson, occur on lot 16, block K, Rossway district, Digby county, and contain magnetite, both massive and in crystals. Some excavation work had been done at the locality many years ago and it was stated that a shipload of ore had been removed. The excavation, however, was so small that I infer that only a very little ore can have been obtained. Last year some further excavations were undertaken disclosing a

small vein. From material lying piled near this excavation I infer that the width of the vein uncovered was only about 5 inches. At present the bed-rock surface cannot be seen. Because of the nature of the occurrence and its environment, there is no reason to believe that any quantity of ore occurs here. There is not sufficient magnetite in the vicinity to produce any marked variations in dip of the Swedish compass, which I employed in an attempt to trace the extent of the vein.

Among the various localities which have been prospected in the last fifty years in this district is one to which Mr. Jameson called my attention. This occurs just north of the road between Digby and Broad cove and about 2 miles from Digby. The locality was prospected about thirty years or more ago. In 1884 the late Dr. R. W. Ells made a special report on it; a copy of this report, now in the possession of Mr. Jameson, was shown to me. At the time of Dr. Ells' visit the excavations were partly filled with earth and, to a great extent, he had to depend on hearsay evidence. Judging from Dr. Ells' description of the deposit, I am lead to believe that this occurrence of ore may be a local segregation of the magnetite of the diabase, and not a vein of the type usually found in this district. Ells states that there may be about 20,000 tons in the deposit as a minimum, basing his estimate on the statements of the prospectors. As the ore occurs in scattered masses with rock matter between, and as rock will also be found to be mixed with the ore, this amount cannot be considered commercially valuable, unless more ore occurs in the same locality. The only way this can be ascertained is by further and expensive exploration, as the surface appears to be mostly obscured by waste. It is possible that a magnetic survey of the vicinity might serve to guide this exploration. On the other hand, the traps themselves carry magnetite, and how far this would interfere with the operation of the magnetometer in this locality can be determined only by trial. It should also be noted that the known part of the deposit lies near the summit of a ridge.

As the ore that is said to occur here is close to the surface, it might pay to take out what there is and sell it locally, without going to any expense for development work. In doing this, information might be obtained which would warrant the expenditure of money on exploration.

All the deposits that have been found on North Mountain have been small and of the nature of pockets. There is no evidence at present available and known to me which would lead me to infer that larger bodies of ore occur. Most of the work was done a generation or more ago and there are no available records of the results obtained. No commercial deposits were discovered then or since.

Copper Ores.—Native copper has been found in many places in the amygdaloidal traps of North Mountain. It has never been mined successfully though much money has been spent in exploration. Within the last three field seasons I have visited a number of localities where it occurs in these traps, but in every instance the amount present is too small to be of commercial importance. On this visit I saw some copper stains, but no native copper, in an amygdaloidal bed on the lot adjacent to that on which the vein of magnetite occurs, lot 18 (?), block R, Rossway. Native copper can also be found at Point Prim, in the west side of Digby Gut, just east of the lighthouse and just above high water mark. It occurs here as sheet copper in veins, and as shot copper. The particles are usually small—so far as I could learn the largest did not exceed half an ounce in weight. Personally, I found only very small pieces. The known occurrence does not contain enough copper to be profitably operated. Whether a greater concentration occurs elsewhere in the vicinity can only be learned by extensive and expensive boring. I do not consider that such work is warranted at present, because of the non-success which has attended boring operations at Cap d'Or, where surface indications show an even greater concentration than we find at Point Prim.

Coal.—No rocks belonging to the Carboniferous or coal-bearing period are known to exist in the locality. The nearest district in which they are found is east of Parrsboro in Cumberland county, 100 miles northeast of Digby. The geology of Digby county and vicinity has been thoroughly investigated, by independent investigators and by officers of the Geological Survey, at various times during the last seventy years. Sir William Dawson and Mr. Hugh Fletcher, the two greatest authorities Canada has ever had on the geology of Nova Scotia coals, have both examined the rocks of the locality, and both unite in stating the coal-bearing strata do not occur in the district.

During the three years that Dr. Bailey spent in preparing his report, he examined the rocks of this and adjacent counties very carefully, and his report contains detailed descriptions of the various localities. His work confirms that of the earlier investigators. Personally, I visited the entire shore section of the red sandstones which occur in the vicinity of St. Mary bay and Digby. I also saw the outcroppings for the beds of several small streams on Digby neck. I can find no reason whatever for believing that coal occurs beneath these sandstones, and I do not consider that the local conditions warrant the expenditure of either private or public funds in boring operations in the expectation of finding coal. From the scientific standpoint a section of these rocks, as disclosed by a bore-hole, would be very interesting and possibly instructive.

(Signed) **Alfred W. G. Wilson.**

DIGBY, N.S., June 5, 1912.

III.

MOOSE MOUNTAIN IRON-BEARING DISTRICT, ONTARIO.

E. Lindeman.

During the field season of 1912, work was carried on in the Moose Mountain iron-bearing district by the writer, assisted by Messrs. A. H. A. Robinson, W. M. Morrison, and W. H. Davies. The work consisted of magnetometric and topographical surveys, conducted in connexion with an examination of the ore deposits.

LOCATION.—The Moose Mountain iron deposits occur some 25 miles north of the town of Sudbury, in the township of Hutton, and extend into the adjoining district of Algoma.

TOPOGRAPHY.—The general character of the country may best be described as a series of more or less parallel, and interrupted rocky ridges. The prevailing trend of these ridges is north and south, the intervening valleys being usually occupied by muskegs.

The drainage of the area is effected through the west branch of the Vermilion river. With the exception of the burned area in the immediate vicinity of Sellwood, the country is thickly wooded. Large areas of stratified gravel and sand, completely hide the bed-rock in many places.

HISTORY.—The existence of iron ore in this district has been known since the early nineties, but it was not until 1909, after the Canadian Northern railway between Sellwood and Key harbour had been completed, that the first shipment of ore was made. The distance from Sellwood, where the mines are situated, to Key harbour, is 82 miles. Up to the present time, mining operations have been confined to the ore deposit known as No. 1. The ore is mined by underhand stoping, crushed to 1″ size, and passed over magnetic cobbers, the finished product averaging about 55 per cent in metallic iron. Owing to depression in the iron ore market, mining operations were discontinued during the greater part of 1911 and 1912, but were recommenced in

September, 1912. The operating company—the Moose Mountain, Limited—is now erecting a modern concentrating and briquetting plant in order to treat the large tonnage of low grade, siliceous magnetite which is available in the district. It is expected that this plant will be in operation during the early part of 1913.

GEOLOGY.—Apparently the oldest rocks in the district comprise a series of metamorphic rocks, characterized by a well developed schistosity, and which might conveniently be referred to as green schists. They consist chiefly of hornblende, plagioclase, quartz, and chlorite.

The more basic members of this group are prevailingly dark green in colour, owing to the large amount of hornblende and chlorite present. Other members, chiefly made up of feldspar and quartz, are of a lighter colour.

Intimately associated with the schists and included in them, is what may be referred to as the iron formation. This consists of a siliceous magnetite, interbanded with more or less cherty and quartzitic material, hornblende and epidote taking the place of the latter in places. The iron formation occurs in numerous detached bodies of varying size, and has been upturned, faulted, and folded together with the schists. The general strike and dip of the iron formation is, therefore, conformable to that of the surrounding schists, which generally is northwest, while the dip varies from 70 to 90 degrees towards the northeast. Locally, however, where the folding has been very intense, a marked divergence in strike and dip frequently occurs.

Intruded into the older schist and the iron formation, are a series of massive greenstones, the mineralogical composition of which varies from a grano-diorite to more basic types. In places, these greenstones often show a porphyritic texture, with large phenocrysts of plagioclase. Some of them undoubtedly represent various basic intrusions, while others may simply be differentiation phases of the same magma.

In colour the greenstones vary from greenish grey to dark green, according to the amount of feldspar and hornblende present. The texture is also subject to wide variation, ranging from very coarse to fine grained. The greenstone is found to intrude the older schist in the most intricate manner, a fact which at many points makes it rather difficult to distinguish them from the older schists. A very common occurrence within the area under consideration, consists of a breccia, made up of larger and smaller fragments of schist, iron formation, and massive greenstone. These are cemented together by a basic, fine grained material of dark colour, which weathers greenish-grey.

Intrusions of greenstone into the iron formation can be seen in several places, and where such occur a concentration of the magnetite has generally resulted. Large intrusions of granite are also found within the area. The chief mineralogical constituent of this rock is a red orthoclase, together with a small amount of quartz and mica. The granite has been intruded into the schist, iron formation, and also into the greenstones referred to above. The youngest igneous rock of the district is a fine grained, dark-coloured dolerite or diabase. The areal distribution of this rock is, however, very limited, and is confined to a few narrow dykes, cutting the older rocks. A good exposure of the diabase is seen at No. 5 deposit, where the iron formation and the granite are intruded by it.

The geological age of the Hutton iron range is, as yet, not determined with certainty, but Coleman has suggested a lower Huronian or Keewatin age for the older schists and the iron formation, while the granite intrusion is referred to as Laurentian. [1]

ORE DEPOSITS.—The iron ores of the Moose Mountain district may conveniently be divided into two classes, viz., low grade siliceous magnetite interbanded with siliceous material, and magnetite associated with amphibole and epidote.

[1] See Ontario Bureau of Mines Report for 1904, page 220.

The chemical composition of the former is shown by the following analysis representing an average sample taken across No. 2 deposit.

Iron	36·70	per cent.
Phosphorus	0·057	"
Silica	45·20	"
Manganese	0·04	"
Alumina	0·25	"
Lime	1·06	"
Magnesia	1·59	"
Sulphur	0·019	"

The analysis of the shipping ore from No. 1 deposit, which is magnetite associated with amphibole and epidote, is given by the Moose Mountain, Ltd., as follows:—

Iron	55·77	per cent.
Phosphorus	0·107	"
Silica	12·78	"
Manganese	0·09	"
Alumina	1·58	"
Lime	3·77	"
Magnesia	3·52	"
Sulphur	0·074	"

The origin of the banded iron formation is now generally believed to be sedimentary. Where intrusions of igneous rocks into the banded iron formation have occurred, local enrichment of magnetite can generally be seen. Indeed, there seems to be good reason to believe that the magnetites which, for instance, as in No. 1 deposit, we find associated with hornblende and epidote, are simply a recrystallization and local enrichment of the original banded iron formation caused by the intrusion of igneous rocks, chiefly greenstone.

Extent of Ore Bodies.—There is available in the Moose Mountain district a very large tonnage of ore which can be cheaply mined under very favourable conditions. The great percentage of this tonnage is, however, of too low a grade to be marketable in its natural state, and will require concentration, before it can be used in the blast furnace. The principal deposit is the No. 2 deposit which has a length of about 5,500 feet. There are also ten other deposits, some of which are of considerable extent. Magnetometric and geological maps are now being prepared which will show the approximate extent of the various ore bodies, and which will accompany the final report of the area.

I.

INVESTIGATION OF THE CANADIAN MARKET FOR VARIOUS MINERAL PRODUCTS IN A CRUDE, OR PARTIALLY PREPARED STATE.

Howells Fréchette.

The investigation, commenced in 1911, for the purpose of determining the requirements of the Canadian market for the various minerals used in the manufacturing industries, was resumed by Mr. Fréchette.

The manufacturers throughout the Dominion were asked for information as to the minerals used by them, the quantity, their specifications as to purity, physical condition, etc., and the present source of supply. Where foreign material was reported as being used, the reason why the Canadian was not used was asked for, and, where possible, addresses of Canadian producers were furnished.

In 1911, data were gathered through parts of the Provinces of Ontario and Quebec. During 1912 the remaining parts of these Provinces were covered as well as the seven other provinces. Ten towns were visited in British Columbia, seven in Alberta, three in Saskatchwan, four in Manitoba, twenty-nine in Ontario, fourteen in Quebec, sixteen in New Brunswick, twenty-six in Nova Scotia, and two in Prince Edward Island. In all, about seven hundred manufacturers were interviewed during the year. The field-work in connexion with this investigation is now practically completed.

II.

CONTINUED EXAMINATION OF THE PHOSPHATE AND FELDSPAR DEPOSITS OF ONTARIO AND QUEBEC.

Hugh S. de Schmid.

The summer of 1912 was devoted to an examination of a number of phosphate and feldspar deposits in Ontario and Quebec. During the greater part of the previous season, the writer had been engaged in the compilation of the monograph on mica, and it had, therefore, been found impossible, owing to the limited time available for field work, to visit these localities earlier.

A visit was first paid to the Parry Sound district, which has engaged the attention of several feldspar operators during recent years. The earlier miners, who were the first to exploit the spar dykes in this region, were all found to have abandoned work, the sole operators being the Standard Feldspar and Silica Mining Company. This Company, in 1911, acquired lot 5 in concession VIII of Conger, a property which had previously been worked in a small way, and has erected a small mill for crushing the spar. This mill was previously established at Thorold, Ontario, but was subsequently removed to the vicinity of the mine, in order to save freight charges on the rough mineral. Only a few men were employed at the mine at the time of the writer's visit, and only a small quantity of spar had been mined. The mill was still in process of erection, the site being located close to the Canadian Pacific railway, Toronto and Sudbury line.

The quality of feldspar both here and at the various other points in the Parry Sound district where mining has been attempted is not of very high grade, and although extensive bodies of spar have been discovered, the proportion of clean mineral, free from admixture with hornblende, biotite, and other iron-bearing minerals, is relatively small. The chief deleterious mineral, and one that is almost universally present in some quantity in the dykes, is biotite. This iron-magnesia mica is found in considerable amount throughout the mass of the spar bodies, but

principally along seams and joints adjacent to the contacts with the enclosing gneiss or schist. The amount of biotite present in the run-of-mine necessitates the most careful handpicking, if the spar is to be used for pottery purposes. Large bodies of quartz occur throughout the dykes, and this mineral, in intergrowth with feldspar, forms locally zones of graphic-granite. Graphic-granitic structure is, however, hardly characteristic of the feldspar bodies, either in the Parry Sound district or at the other localities in Ontario, where the mineral occurs in quantity.

After leaving the Parry Sound region, a visit was paid to the feldspar occurrence at Manikuagan bay, on the east side of Piashti bay, north shore of the Gulf of St. Lawrence. This property is owned by the Canadian Feldspar Company, of Montreal, which has carried out a small amount of surface work. No machinery has been employed. The above Company is understood to have leased the property to a syndicate, who intended operating on a larger scale with the aid of steam. The machinery however, was never shipped to the mine, and, when visited, only a foreman was found on the ground.

The spar is of a pink-white colour and forms the main rock-mass of a tongue of land, some 150 feet wide, which juts out on the north side of a small peninsula to the east of Piashti bay. The total length of the spar belt so far uncovered is about 1,000 feet. The enclosing rock is black hornblende-schist, which forms the predominant rock-type of the region. This schist has been intruded, and has suffered intense shattering, by a pink-grey granite; this latter rock sometimes appearing locally in far greater mass than the schist which it penetrates. The deposit of feldspar referred to would appear to be a local segregation from the mass of the granite, which, at other points, possesses normal granitic structure and composition. Although, by careful cobbing, unusually large plates and fragments of pure spar can be obtained, the average run-of-mine mineral is not of very high grade. Biotite mica is an accessory mineral which occurs in some quantity and affects the quality of the spar. An earthy mineral, also, of a grey-green colour, and obviously a decomposition product of some earlier species, proves to be almost universally present throughout the dyke-mass. The presence of this earthy or clayey substance in the spar, does much to detract from its value, and will probably preclude its use for pottery purposes.

The writer subsequently visited the mica-bearing pegmatites near Murray Bay and Tadousac, Que. None of these properties are now being worked for mica, and the feldspar appears to be too intimately mixed with quartz and with mica to allow of its being profitably mined.

On returning from the St. Lawrence reigon, the Lièvre river and Templeton districts, in the Province of Quebec, were again visited, and recent developments at the phosphate and feldspar mines noted. Visits were also made to the phosphate and feldspar mines in Frontenac and Lanark counties, Ont., where information relative to these two minerals was gathered for the monographs now in process of compilation.

With the exception of two mines, the Little Rapids mine, at Poupore, on the Lièvre river, and the Blackburn mine, in Templeton, both in the Province of Quebec, work on all the phosphate properties in Canada has ceased. At the former mine, about 300 tons of phosphate were produced during the year—the whole of this quantity being taken out in the course of development work in the search for mica. At the Blackburn mine a little phosphate is similarly saved.

Unless the apatite from the Canadian phosphate mines should prove to be of value for some special purpose hitherto unrecognized, there would appear to be no possibility or likelihood of a future revival of the industry.

Appended are tables showing the annual production of both phosphate and feldspar in Canada since the inception of the industries. From these tables it will be seen that the output of phosphate in 1911 was the lowest since 1896, and the second lowest since the commencement of mining. The amount of feldspar raised in 1911, on the other hand, showed an increase over the production of the previous year of nearly two thousand tons, the increase in value being $4,272.

Annual Production of Phosphate in Canada, 1886-1911.

Calendar Year.	Tons.	Value.	Average value per ton.
		$	$ cts.
1886	20,495	304,338	14 85
1887	23,690	319,815	13 50
1888	22,485	242,285	10 77
1889	30,988	316,662	10 21
1890	31,753	361,045	11 37
1891	23,588	241,603	10 24
1892	11,932	157,424	13 20
1893	8,198	70,942	8 65
1894	6,861	41,166	6 00
1895	1,822	9,565	5 25
1896	570	3,420	6 00
1897	908	3,984	4 39
1898	733	3,665	5 00
1899	3,000	18,000	6 00
1900	1,415	7,105	5 02
1901	1,033	6,280	6 07
1902	856	4,953	5 79
1903	1,329	8,214	6 18
1904	817	4,590	5 62
1905	1,300	8,425	6 48
1906	850	6,375	7 50
1907	824	6,018	7 30
1908	1,596	14,794	9 26
1909	998	8,054	8 07
1910	1,478	12,578	8 51
1911	621	5,206	8 38

Annual Production of Feldspar in Canada, 1890-1911.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
		$			$
1890	700	3,500	1901	5,350	10,700
1891	685	3,425	1902	7,576	15,152
1892	175	525	1903	13,928	18,966
1893	575	4,525	1904	11,083	22,166
1894	Nil.	Nil.	1905	11,700	23,400
1895		*2,545	1906	16,948	40,890
1896	972	*2,583	1907	12,584	29,819
1897	1,400	3,290	1908	7,877	21,099
1898	2,500	6,250	1909	12,783	40,383
1899	3,000	6,000	1910	15,809	47,667
1900	318	1,112	1911	17,723	51,939

* Exports.

III.

FURTHER INVESTIGATION OF GYPSUM AND SALT INDUSTRIES OF CANADA.

L. Heber Cole.

The writer left Ottawa on August 20, in order to investigate the gypsum industry of the Maritime Provinces. This work was undertaken not only with a view to securing data for a report on the gypsum industry of Canada, but also to gather information for the revised edition of the Report on the Mining and Metallurgical Industry.

In investigating present practice adopted in the manufacture of gypsum products, three weeks were spent in Manitoba, in which Province the industry is making rapid progress. A few days were also spent in and around the Windsor district, completing the compilation of data for a bulletin on the salt industry of Canada.

The gypsum industry of the Maritime Provinces consists, chiefly, in quarrying the crude gypsum and in shipping it in that state to the United States. There it is calcined, and, in part, shipped back to Canada as a finished product. The industry on the whole is gradually increasing, but, as regards the extent to which calcining is at present carried on in Canada, there is still ample opportunity for growth. At present there are three mills crushing and calcining plaster in the Maritime Provinces, and even with the product from these mills being sold throughout eastern Canada, considerable quantities of the finished product are still imported from the United States.

It is only lately that any endeavour has been made to place the advantages of the hard wall plasters before the public, yet, by demonstrating the method of application of these plasters and by means of advertising pamphlets describing their adaptability for different uses, the producers could readily increase the volume of their sales. Concerted effort on the part of all producers manufacturing in Canada would, by the issuing of descriptive literature, greatly benefit the industry.

A noticeable feature in connexion with nearly all the quarries in the Maritime Provinces is the heavy overburden which must be removed before the gypsum can be quarried. The present somewhat crude method of removing the overburden consists in the use of single horse Scotch carts, or in the case of the larger quarries, in the use of the steam shovel. In many of the quarries visited, the nature of the ground was such that hydraulic stripping could probably be employed to advantage for the removal of this overburden. In only one place had this system been attempted, and then only on such a small scale, that it could not be considered as a conclusive test. The results obtained, however, were such as to warrant further trials.

The following brief references refer to properties visited in the Maritime Provinces:—

The Windsor Gypsum Company, a New York organization, is operating a gypsum quarry one-half mile to the northwest of Newport station and about 3 miles to the east of Windsor. The extent of the area opened up is about 100 yards north and south by 300 yards east and west. A working face of 20 feet is at present being worked, the depth of overburden to be stripped amounting to from 10 to 15 feet. The gypsum, which is of a good quality, is broken by powder and transported by horse and cart to the loading platform, located on a spur line from the Dominion Atlantic railway. The rock is then hauled to the shipping pier of the Company at Windsor, and there loaded into barges of 1,200 to 1,600 tons capacity. By these it is carried to Newbury, N.Y., where it is calcined, and prepared for the market.

The Windsor Plaster Company is at present opening up new quarries at West Gore, which, when in operation, will supply all the crude rock for their mill at Windsor. The rock now being treated in this mill is obtained from several of the quarries in the vicinity of Windsor.

The mill, consisting of a three story building, is being operated steadily; the output includes several grades of hard wall plaster, plaster of Paris, etc., the former being placed on the market under the trade name of "Selenite."

The rock from the quarries is passed through crushers and grinders and is calcined in two, 10-ton, circular calcining kettles. After screening—the overs being put through small buhr stone mill—the stucco is passed through a mixing machine, mixed with wood fibre, and prepared for the market.

In connexion with this mill is a boiler plant, blacksmith shop, cooperage, with capacity for 1,000 barrels per day, storage bins, office, barn, etc.

The Wentworth Gypsum Company is operating an extensive quarry 3½ miles to the east of Windsor. This Company owns an area of about 1,200 acres all underlain by gypsum, and is carrying on the largest exporting business of its kind in the whole of Canada. The shipments this year (1912) will be in the neighbourhood of 150,000 tons of crude gypsum. Considerable quantities of anhydrite are encountered in this quarry, but the gypsum is of good quality. The overburden of earth and clay which must be stripped, varies from 10 feet up to an occasional depth of 45 feet. It is being handled by two steam shovels, one working above the gypsum, and the second, a smaller one, operating in the quarry. The gypsum is drilled by hand auger drills, blasted, and hauled by one-horse carts to a dumping platform in the centre of the quarry beside which the 6-ton cars are placed. The loaded train is hauled 2½ miles over a narrow gauge railway to the Company's shipping pier on the St. Croix river, and from there it is transported by barges (2,500-ton capacity) to New York, where it is calcined. Over 200 men are employed in this quarry.

The Newport Plaster Mining and Manufacturing Company has quarries situated about 2½ miles to the south and west of Avondale. At this point, the Company's shipping piers are located, the whole of the product in the crude being shipped to the United States.

The surface stripping which has to be carried on in these quarries is very light, varying from 2 feet to 15 feet. A steam shovel is employed for stripping, and also loads the gypsum directly into cars on the narrow gauge railway laid right to the faces of the quarry. A tunnel is being driven on an incline to connect with another quarry which is being opened up on a lower level. The rock from this latter quarry is at present being hauled up an incline by a small hoist, dumped into carts, and then hauled a quarter of a mile to the narrow gauge railway. The shipping barges are of 2,200 tons capacity. A total force of 125 men is employed at the quarries, shipping pier, and on the railway. The product is shipped to New Brighton, Staten Island, and New York, U.S.A.

The Great Northern Mining and Railway Company's quarry and mill are situated 3½ miles to the east of Eastern Harbour, Cheticamp, Cape Breton.

The rock for the mill is obtained entirely by quarrying methods. The quarry at present being worked lies about one-fourth of a mile to the east of the mill. A narrow gauge track with a falling grade from the quarry, allows the small cars to descend by gravity to a point on the side of the hill above the mill. From this point an incline 40 feet long permits the car to be lowered by means of a small hoist to the crusher bin.

The quality of the rock is good, practically no stripping is required, and consequently the gypsum is sent to the mill in a very clean condition.

The mill containes one 10-ton kettle with preliminary drier, but preparations are now in progress for the installation of another complete kettle unit.

The Company employs about 65 men in connexion with the quarry, mill, railway, and shipping pier.

The Victoria Gypsum Mining and Manufacturing Company has its quarry at St. Ann, C.B., a distance of 3½ miles to the west of its shipping pier at Munro point, on St. Ann bay. The gypsum quarried is of a pure white variety, but con-

siderable anhydrite is being encountered in the lower part of the deposit. The yearly output is between 30,000 and 40,000 tons. Very little stripping is required, the rock, when stripped, being very clean and free from clay and dirt. A face of 50 to 60 feet is at present worked, a force of 175 men being employed.

The Newark Plaster Company is operating a small quarry at McKinnon Harbour, Cape Breton (Ottawa Brook). The gypsum is badly broken up owing to the presence of sink holes, and considerable anhydrite is encountered. The crude rock, after being drilled by auger drills and blasted, is hauled in one-horse dump carts to the narrow gauge railway which is a mile in length. The shipping pier is on the Bras d'Or lakes. An average force of 25 men is employed.

The Maritime Gypsum Company, Limited, owns an area of 14 acres, and is operating a quarry 1 mile to the northwest of Nappan station on the Intercolonial railway. Operations are being carried on below the drainage level, the floor of the quarry being some 60 feet below the general level of the surrounding country. Very little stripping is required. A Ledgerwood cable system, with 1·7 ton bucket, is employed to hoist the broken rock from the bottom of the quarry and transfer it to the stock pile, storage bins, or railway cars. Electric power is used for operating cable system and pumps. The Company owns two locomotives and a railway line 3 miles long, which connects the quarry with its shipping pier on the Cumberland basin. The average number of men employed is about 40, and the yearly production is about 30,000 tons. The crude rock is shipped to New York.

Mr. Albert Parsons is operating quarries at Cheverie and at Walton, N.S.

The Cheverie quarries are located at the southeast end of the village of the same name, and to the northwest of the shore road. The deposit is very pockety and no high faces have as yet been developed, but the rock produced is of very good quality. A haul of less than one-half a mile places it on the stock pile at the shipping pier, whence it is transported by barges to New York. An average force of 40 men is employed.

The Walton quarries, one mile from Walton, have probably the largest working face of any quarry in the whole Province. At the centre of the quarry, a face over 100 feet in height is obtained. The rock is of the grey variety, and is transported in two-horse carts to the shipping pier at Walton village. About 30 men are employed.

The Albert Manufacturing Company, with mill and quarries in and near Hillsborough, N.B., are carrying on extensive operations in the manufacture of plaster and export of the crude gypsum.

During the summer months open quarries are operated. The gypsum produced is of a good white quality, very suitable for the best grades of wall plaster. In the winter, underground operations are also carried on, and a considerable quantity of a high grade alabaster is mined. Both properties are connected by a private railway with the mill and shipping wharves, 3½ miles distant.

The Company's new mill is now in full operation. This is the third to be erected since the Company came into existence in 1873 or 1874, the first two mills having been destroyed by fire. The new plant is very complete, and the mill has a capacity of 1,000 barrels per day of calcined plaster.

The machinery in the mill consists of a complete system for crushing and grinding, four 10 ft. kettles, gas fired, screening machinery, and packing machinery and shed. Cooperage shed, boiler plant, and engine-room adjoin main buildings.

About half a mile from the mill are the wharves from which the Company ships both the crude rock and the calcined plaster, the former being sent to the United States, and the latter to Montreal and other parts of the Dominion. The Company employs from 325 to 350 men at quarries, mill, and wharves.

The Manitoba Gypsum Company, with head offices and mill at Winnipeg, and quarries at Gypsumville, have increased their output slightly over last year. In their mill at Winnipeg, several important changes have been made, the chief of these being

the installation of a second rotary dryer of the Cummer type, similar to the one already in use. The demand for the products of hard wall plaster in the western provinces is steadily increasing, in consequence of which the mills in the west are all working at full capacity.

The Dominion Gypsum Company's new mill on the western outskirts of Winnipeg, is now completed and running at its full capacity. Seven grades of hard wall plaster and plaster of Paris are being produced.

The mill, which has a capacity of from 125 to 150 tons of calcined plaster per day of 12 hours, consists of a crushing and grinding plant, two 10 ft. kettles, regrinders, mixing machines, and automatic weighers and packers. The material passes from one process to another by means of steel elevators. Foundations are being laid for the installation of a Coles-Ruggles rotary dryer for the preliminary drying of the crude gypsum before crushing. Sidings from the Canadian Northern railway and the Canadian Pacific railway connect with this mill, thus affording ample facilities both for receiving the crude rock, and also for shipping the finished product.

CANADIAN SALT COMPANY.

Two days were spent in and around Windsor, and a visit made to the Canadian Salt Co.'s new plant at Sandwich, for the production of caustic soda and bleaching powder. This plant is now being operated continuously, and additions are already being made to increase its capacity.

OTHER MINING INDUSTRIES.

In addition to the foregoing work, data, to be incorporated in the revised edition of the Report on the Mining and Metallurgical Industry of Canada, was gathered concerning the gold, tungsten, and manganese mines of Nova Scotia, and also on some of the grindstone quarries of the Maritime Provinces.

The gold mining industry in Nova Scotia is at the present time very inactive, the output for the year 1912 being the lowest in the history of the industry in that Province. The causes of this inactivity are many, the principal ones being insufficient surface and underground prospecting previous to deciding on equipment, overcapitalization of companies, unsound mine promotion and stock gambling, and the failure to apply the proper methods of mining.

In the case of many districts in Nova Scotia in which gold was found, claims were staked and large plants erected, before any idea of the extent of the veins, either on the surface or underground, was obtained. Consequently many of the properties which might have yielded a fair return if operated on a reasonable scale were, owing to lack of funds, of necessity abandoned, before their proper value was proved.

Like other mining districts, Nova Scotia has had its share of mine promoters and of speculation, with the consequent influence detrimental to the Province.

The districts visited were all producing in a small way, which goes to show that if properly managed, and operated on a reasonable basis, many properties, which have proved failures under excessive capitalization and unnecessary equipment, could be made to yield a profit.

The following properties are in operation and were visited during the summer:—

Switzer Gold Mining Company, Fifteenmile brook.
Uniac Mines & Power Company, Chester Basin.
Golden Group Mining Company, Montague.
Petpeswick Mining Company, W. Petpeswick.
W. A. Brennan, Oldham.
M. J. O'Brien and associates, Renfrew.
Touquoy mine (tributers), Moose river.

Caribou Gold Mines, Limited, Caribou.
Dominion Leasing Company (Tangier mine), Tangier.
Boston & Goldenville Mining Company, Shiers Point.
Goldenville Mining Company (construction work), Goldenville.
S. R. Giffon & Sons, Goldboro.

The property operated by the Scheelite Mines, Limited, in the western part of the Moose River gold district, was also visited. This Company is carrying on prospecting work and is producing a limited quantity of the mineral scheelite. A small shipment has already been made to the United States and another shipment is ready at the mill. A very complete mill has been erected on the property.

The Nova Scotia Manganese Company, with mine and mill at New Ross, N.S., have a well-defined vein of pyrolusite developed for several hundred feet in length, and at a depth of 100 feet. A complete mill for screening has been erected and is in operation. A wagon road, leading to tide water, a distance of but 14 miles, is in course of construction.

The following grindstone quarries were also visited with a view to bringing the data regarding them up-to-date.

Miramichi Quarry Company, Limited.
Reed Stone Company.
W. R. Knowles.
The Dorchester Stone Works.
James W. Sutherland.

A short visit was paid to the oil and gas area which is being developed by the Maritime Oil Fields, Limited. This Company has its Canadian offices in Moncton, N.B., and its wells are located in Albert county, 5 miles to the north and west of Hillsborough. There are already 19 wells producing either gas or oil and in certain cases both. The oil is shipped in the crude state and the gas is piped to Moncton and to Hillsborough, where it is used for industrial and domestic purposes.

I.

PRELIMINARY REPORT OF INVESTIGATIONS AT THE RESEARCH LABORATORY OF APPLIED ELECTRO CHEMISTRY AND METALLURGY, SCHOOL OF MINING, QUEENS UNIVERSITY, KINGSTON, ONT., FOR THE MINES BRANCH, DEPARTMENT OF MINES, CANADA (JANUARY, 1913).

H. T. Kalmus.

Director of the Laboratory.

The arrangement between the Mines Branch and the School of Mining at Kingston, according to the terms of which this laboratory was established for original research work in applied electro-chemistry and metallurgy, was abundantly set forth in the last summary report of the Mines Branch (pp. 27-30, 1911). Accordingly, this laboratory has been operating since April, 1912, with a staff of from one to three research associates and assistants, an analyst, and a mechanic.

During this short time it has not been possible to bring any of the investigations to completion, but sufficient data have been accumulated to warrant a preliminary statement at this time. This is given primarily to place the results in the hands of those most interested at as early a date as possible, to act as a stimulus for others interested in similar research work, as well as to establish priority for certain results which may ultimately prove to be of great importance.

Of the several investigations to be and being undertaken the one on the metal cobalt and its alloys has thus far received the most attention, and is to be particularly reported upon at this time.

AN EXPERIMENTAL INVESTIGATION OF THE METAL COBALT AND ITS ALLOYS.

The mines receive very little return for the cobalt content of their ores. There have been about 175,000 tons of silver bearing ore shipped from the Cobalt district since 1904, carrying approximately 7,000 tons of cobalt, which at a reasonable market value for metallic cobalt, should have been worth in the neighbourhood of $10,000,000. For this the mine owners received only $566,000. Much of this cobalt is lying as residues, etc., at the smelters, for practically the only market which it finds is a limited one for the use as blue colouring substance. For this purpose the smelters ship black cobalt oxide, which consumes about one-third of the present output of the camp, leaving to be cared for, the remaining two-thirds and the surplus from other years. Thus there is a potential value of many millions of dollars in the cobalt metal of Ontario which is not being realized. Mr. Gibson, in the Annual Report of the Ontario Bureau of Mines, 1912 (page 22), writes: "There is room in the cobalt situation for a new use for this element which will absorb large quantities, and so widen the market."

RAW MATERIALS FROM THE SMELTERS.

Waste products running high in cobalt may be obtained in a variety of forms from the smelters, but inasmuch as the process for the production of fairly pure cobalt oxide has been very completely worked out and is being practised on a large

scale by the Canadian Copper Company,[1] Copper Cliff, Ont., the Deloro Mining and Reduction Company, Deloro, Ont., the Coniagas Reduction Company, Thorold, Ont., and the Canada Refining and Smelting Company, Ltd.,[2] Orillia, Ont., it seemed advisable to use this oxide as an initial substance.

The writer has discussed the cobalt situation with those in charge of the various smelters and oxide plants, and has found everywhere a most enthusiastic interest in the work of this laboratory on cobalt and a great willingness to co-operate as far as possible.

In this connexion the writer wishes to express the indebtedness of this laboratory to the Deloro Mining and Reduction Company, who have presented it (for experimental purposes) with about 500 pounds of first grade cobalt oxide, and with a similar amount of mixed cobalt and nickel oxides. Unless stated to the contrary, these oxides are the materials which have been used as the initial substance for the experiments to be mentioned in this preliminary report.

PURIFICATION OF COBALT OXIDE.

In much of the work to follow it is important that the influence of the metal cobalt be sharply differentiated from that of iron and nickel which are the principal metallic impurities of the original oxide. As well, before undertaking the investigation of a large series of alloys of cobalt, it is important that the properties of the pure metal itself be established. For these reasons a purification of a certain amount of the oxide was undertaken. The method employed was in principle that in standard practice in the Canadian cobalt oxide plants, but the author wishes to express his indebtedness to Prof. S. F. Kirkpatrick of the School of Mining, Kingston, for many important details.

The iron was removed from a solution of the oxide in hydrochloric acid by precipitation with marble, and a separation of the nickel was brought about by use of the differential precipitation of the hydrates of nickel and cobalt by means of a bleach solution, and finally the sulphur was removed with sodium carbonate and hydrochloric acid.

The original oxide analysed:—

Cobalt	70·36	per cent.
Nickel	1·12	"
Iron	0·82	"
Sulphur	0·45	"

The oxide purified by this method (June, 1912) analysed:—

Cobalt	71·99	per cent.
Nickel	0·04	"
Iron	0·11	"
Sulphur	0·02	"

PREPARATION OF METALLIC COBALT BY DIRECT REDUCTION OF OXIDE.

From the fairly pure cobalt oxide (Co_2O_3) there are several possible methods of obtaining metallic cobalt in a reasonably pure form.

(1) By reduction with hydrogen gas.
(2) By reduction with carbon monoxide gas.
(3) By reduction with aluminium.
(4) By reduction with carbon.

[1] Cobalt plant recently closed down.
[2] Main buildings destroyed by fire early this month, January, 1913.

With the present commercial possibilities for the production of water gas, of producer gas, and indeed of pure hydrogen as practised by the General Electric Co., Schenectady, N.Y., for the reduction of metallic oxides, any of these four methods might ultimately be used on a large commercial scale. Hence, an investigation of the chemical equilibria involved in these reactions has been and is being made.

REDUCTION OF COBALT OXIDE BY HYDROGEN GAS.

One set of experiments has been completed and another set is under way to determine the rate of the reaction $Co_2O_3 + 3H_2 = 2Co + 3H_2O$, in the presence of an excess of hydrogen, and at various temperatures from 500°C. to 1,100°C.

Preparation of Hydrogen.—Hydrogen for this reduction was in part prepared electrolytically and in part bought in cylinders from standard chemical supply houses. In either case it was purified by passing through towers of potassium permanganate, sodium hydroxide, concentrated sulphuric acid, and over hot copper. This pure dried hydrogen was passed into a horizontal tube electric furnace which was the reaction chamber, and from the end of which the excess of hydrogen was burned.

Electric Furnace or Reaction Chamber.—The furnace employed had a horizontal tube heating chamber, 2½″ diameter by 15″ in length. It operated at 25 volts and absorbed up to 12 KW. The resistor was a series of concentric carbon rings which could be pressed more or less tightly together by means of suitable adjusting screws. By this means the temperature could be controlled at will to be anything from 500°C. to 1,500°C.

Charge and Run.—Alundum boats were charged with a shallow layer of cobalt oxide (Co_2O_3), both boat and oxide having been dried to constant weight. This charge was kept within the heating chamber for various lengths of time at various temperatures in an excess of hydrogen. At the end of a definite measured time the boats were cooled and reweighed to ascertain the amount of reduction.

All the observations were made in duplicate with two boats in parallel, and concordant results were for the most part obtained. A series of observations was made, of about 20 weighings each, at the following temperatures, 585°C., 724°C., 825°C., 964°C., 1,065°C.

Temperature Measurements.—Temperature measurements were made with a platinum, platinum-rhodium thermo-element, which was standardized from time to time against known melting points of a series of metals.

Preliminary Conclusions.—The reduction at the lower temperatures takes place much more slowly than at the higher temperatures, and at each temperature, after a short time, the rate of reduction becomes so slow that the reaction could not economically be carried further. For example, at 585°C. at the end of 15 minutes the reduction is 28 per cent[1] complete, whereas at the end of an hour it has only increased to 30 per cent[1] complete. As against this, at the higher temperature 1065°C. at the end of 7 minutes the oxide is 89 per cent[1] reduced, and shows less than 1 per cent further reduction during the next half hour.

A complete set of curves will ultimately be published plotting time of reaction against percentage of reduction, each curve showing the phenomenon at one temperature. One complete set of these curves has been determined and experiments are being carried out for a second set.

Until this second set has been completed, the figures given must be considered as preliminary. There may have been some error introduced in the case of this hydrogen reduction, by failure to cool the boats in an atmosphere of hydrogen, and the second set of runs now in progress is being made taking this precaution. This re-oxidation

[1] These percentages are based upon cobalt oxide analysing 71·99% Co which was used, and which is somewhat higher in Co than Co_2O_3.

in the case of hydrogen reduction could not be very great, as was found when reducing with carbon monoxide (CO), for at the higher temperatures almost complete reduction was obtained with hydrogen, the weighings having been made after cooling in air.

Economic Consideration.—Obviously from such complete data it will be possible to determine, for any given type of furnace and with a definite cost of power, what would be the most economical temperature of operation for this reduction, balancing the cost of maintaining the higher temperatures against the increased rate of the reaction at those higher temperatures.

REDUCTION OF COBALT OXIDE BY CARBON MONOXIDE GAS.

In a manner similar to that of the reduction of cobalt oxide (Co_2O_3) by hydrogen, the reduction with carbon monoxide (CO) gas at various temperatures was studied.

Preparation of Carbon Monoxide.—Carbon dioxide generated in the usual way by the action of hydrochloric acid on marble, after having been purified by passing through water, concentrated sulphuric acid, and over powdered sodium carbonate, was passed through a vertical tower of red hot granular charcoal. The charcoal tower was heated electrically, and the rate of outflow of carbon monoxide (CO) gas generated there was controlled by suitable valves. From the tower the carbon monoxide was passed directly into the electric furnace or reaction chamber, from the further end of which the excess of gas was burned.

Electric Furnace or Reaction Chamber.—This furnace was identically that used for the reduction of cobalt oxide (Co_2O_3) by hydrogen and has been described above.

Charge and Temperature Measurements.—Alundum boats were charged with a shallow layer of cobalt oxide, and placed within the reaction chamber, and temperature measurements were made with a platinum, platinum-rhodium thermo-element, both just as described above under hydrogen reduction.

Removal of Boats for Weighing.—After allowing the reaction $Co_2O_3 + 3CO = 2Co + 3CO_2$ to proceed for a measured length of time, boats run in parallel were removed, cooled, and weighed to determine the amount of reduction. In this case, apparently contrary to that of the hydrogen reduction, there was a considerable amount of reoxidation during cooling, so that it was necessary to cool the boats in an atmosphere of carbon monoxide (CO). A special container was devised to allow the charges to be removed from the furnace and cooled, remaining throughout in a carbon monoxide atmosphere.

Preliminary Conclusions.—The runs with carbon monoxide are still in progress, but a sufficient number have been made to denote that the curves showing the rate of reaction at different temperatures are similar to those for hydrogen, but that carbon monoxide (CO) is a much more vigorous reducing agent. We find, for instance, that at the low temperature 585° C., reduction is nearly 90 per cent complete at the end of 15 minutes with CO, whereas at the same temperature with H_2 at the end of 15 minutes the reduction was less than 30 per cent complete.

Cobalt Carbonyl.—We have found no evidence of the formation of cobalt carbonyl, $Co(CO)_4$, similar to the compound nickel carbonyl, $Ni(CO)_4$, which is of such great metallurgical importance as the basis of the Mond process. Nickel carbonyl is formed at 150°C. and decomposes at about 200°C.[1] Correspondingly it is not unlikely that cobalt carbonyl will exist only in a very restricted temperature interval.[2] A study of this would be of great interest to those engaged in the cobalt industry, and may be undertaken in this laboratory in connexion with its further work on carbon monoxide (CO) reduction of cobalt oxide (Co_2O_3).

---

[1] "Elektro-Metallurgie des Nickels," W. Borchers, pp. 35.

[2] According to Mond and Hirtz, J. Chem. Ind. 1908, pp. 1017, CO $(CO)_4$ forms only at very high pressures and very low temperatures.

REDUCTION OF COBALT OXIDE BY ALUMINIUM.

Several experiments were tried, using a Goldschmidt reaction crucible, to bring about satisfactory reduction of cobalt oxide (Co_2O_3) with metallic aluminium.

This reaction is extremely vigorous, so much so that it could hardly be said to be under control, and consequently would not lend itself to commercial production of metallic cobalt, except for very special purposes. However, we have been able to use this method for the preparation of cobalt to be used to make alloys of aluminium, but the yields have not been satisfactory.

REDUCTION OF COBALT OXIDE BY CARBON.

The theoretical amount of powdered carbon, charcoal, or coke to reduce a charge of approximately 5 pounds of cobalt oxide was intimately mixed with it, and heated in an oil crucible furnace or in an electric crucible furnace.

In this way it was found possible to obtain a yield of metallic cobalt in the neighbourhood of 95 per cent, and in many cases between 99 per cent and 100 per cent. The complete data of these runs will be published independently, but a few characteristic figures are given below to show that at a temperature of 1,200° C., a run of about one hour serves to bring about complete reduction, while at a temperature of 900° C., 2½ hours are not sufficient.

Analysis shows that the metal obtained by carbon reduction is fairly free from carbon, running in the neighbourhood of a few tenths of one per cent. Moreover, by adding a small quantity of lime to these melts at the temperature of the electric furnace, the carbon may be almost completely removed. Some of the analyses for carbon before adding lime are given with the yields.

Reduction of Cobalt Oxide by Carbon.

Experiment No.	Charge.	Temperature.	Time of reduction.	Yield of metal in terms of theoretical amount.	Remarks.	%C in metal.
H87 F......	4 lbs. Co_2O_3..... 6·6 oz. C.	1500°C	1½ hrs.	98·3%	Electric furnace..........	0·23
H87 A......	5 lbs. Co_2O_3..... 8·3 oz. C.	1200°C	1½ "	87·2%	Oil furnace..........	0·22
H87 B ...	4 lbs. Co_2O_3 .... 6·5 oz. C.	1200°C	1 "	99·7%	Electric furnace.........	0·29
H87 C ..	4 lbs. Co_2O_3.... 6·9 oz. C.	1200°C	½ "	97·8%	Oil furnace...............	0·18
H87 D......	4 lbs. Co_2O_3..... 6·9 oz. C.	1200°C	2 "	100%	Electric furnace........ .	0·20
H87 E	4 lbs. Co_2O_3..... 6·9 oz. C.	1500°C	1 "	96·6%	"	0·22
H87 G......	4 lbs. Co_2O_3..... 6·6 oz. C.	900°C	2½ "	....	Reduction not complete. Oxide visible.	....
H87 G	"	1550°C	10 min.	99%	After run at 900°C. charge was brought above melting point and poured.	0·21
H51...	10 lbs. C_2O_3..... 1 lb. C.	1200°C	1¾ hrs.	93%	Oil furnace. 3 oz. lime added before pouring.	0·086

Economic Considerations.—This method of preparation of metallic cobalt by direct reduction with carbon could be practised industrially at very low cost. We are able, in electric furnaces not especially designed for this work, to reduce enough oxide to make 15 pounds of metal in about 1 hour, absorbing 20 KW. Thus on a commercial basis the power charge for this reduction would be small.

PROPERTIES OF METAL COBALT.

The properties of the metal cobalt and of its alloys have been and are being studied under the following headings:—

(1) Melting points.
(2) Casting properties.
(3) Turning, rolling, and forging properties.
(4) Hardness.
(5) Tensile strength.
(6) Compressive strength.
(7) Corrosion in acids and atmosphere.
(8) Structure as determined by micro-photographs.
(9) Magnetic properties.
(10) Thermo-electric power.
(11) Electro-motive force as electrode of voltaic cell.
(12) Plating properties.

Melting Point of Metallic Cobalt.—A long series of melting point determinations was made in a General Electric Co. Arsem. Electric Vacuum Furnace, using pure alumina crucibles and a charge of about 50 grammes of metallic cobalt. The melting point was determined by regulating the current through the furnace so that the charge was brought to a temperature about 100° above its melting temperature, and by then reducing the current to a magnitude such that a gradual cooling of the melt through its melting point was obtained. Temperature readings were made at 20 second intervals, which gave uniform concordant results, both among themselves for an individual run, and from one run to another. Temperature observations were made with a Wanner Optical Pyrometer which was checked up before and after each run against an amyl-acetate lamp standard, in accordance with a calibration certificate from the Physikalisch-Technische Reichsanstalt at Charlottenburg. This pyrometer as well was checked against known melting points from time to time, which observations agreed with the calibration curve to within a few degrees.

The mean of a set of six such measurements, the average deviation of the single observations from the mean being 1·8°, gives the *melting point of pure cobalt* to be 1,497°C.

A weighted mean of the best previous determinations of this melting point is 1,493°C. The fact that our measurements were made in vacuo and the others at atmospheric pressure would account for but a small part of this difference of 4°C. It is not unlikely that our cobalt was purer than that for most of the other determinations.

Casting Properties of Metallic Cobalt.—Cobalt when prepared in a fairly pure state by reduction from the oxide with hydrogen, with carbon monoxide, or with carbon, was poured to make various sizes and shapes of castings, both in sand moulds and in iron moulds. Cobalt, similar to iron, shows a marked tendency to occlude gases in casting. We obtain perfectly sound castings by degasifying with manganese and by soaking, that is by holding the melt for about one hour at a temperature not very far above its melting point.

Turning, Rolling, and Forging Properties of the Metal Cobalt.—Castings of cobalt in the neighbourhood of 99·5 per cent pure may be readily turned with the ordinary lathe tools. It is a beautiful metal resembling nickel, but tougher and more lustrous. Observations of the rolling and forging properties are being made.

Hardness of the Metal Cobalt. Testing Machine.—The hardness of this metal and of its alloys was tested on a Standard Olsen Hardness Testing Machine of 10,000 pounds capacity (Tinius Olsen and Co., Philadelphia, Pa.).

Brinell Hardness.—Hardness measurements made by this machine are in reality measurements of the resistance of the material in question to penetration by a hardened steel ball of given diameter, placed upon it and subjected to a definite load. On the Brinell system the hardness is the ratio of the load in kilograms to the area of the spherical surface of the cavity produced, measured in square millimetres.

All hardness measurements of the metal cobalt and of its alloys have been computed in terms of the Brinell system. We have measured the Brinell hardness, under the same conditions that we make our new hardness determinations, of a series of common substances, a table of some of which is given below, and to which hardness of the new materials may be referred for comparison. In each case the figure is the mean of several observations, and they are reproducible within a few per cent.

Brinell Hardness Measured on Olsen Hardness Testing Machine.

Load 3,500 pounds.

Copper, rolled sheet	65·6
Swedish iron	90·7
Wrought iron	92·0
Cast iron	97·8
Mild steel	109·9
Tool steel	153·8
Spring steel	160·3
Tool steel, S.H.	180·0

Brinell Hardness of Cobalt.—About 25 Brinell hardness measurements have been made with fairly pure cobalt, which vary among themselves depending upon the method of casting and upon the heat treatment of the sample. Some attempt is being made to differentiate the hardness of cobalt cast in sand moulds, in iron moulds, and to give some figures showing the effect of annealing and quenching. These data will be given in the subsequent complete publication, but for the present we may give as the mean of a number of determinations the following values—

Brinell hardness, metallic cobalt, chilled from melting point	90·8
Brinell hardness, metallic cobalt, annealed from 250°C	77·3

These figures while not final serve to show that cast cobalt has about the hardness of wrought iron.

TENSILE STRENGTH AND COMPRESSIVE STRENGTH OF METALLIC COBALT.

Tensile and Compression Measuring Machines.—The tension and compression tests were made on a Riehlé Universal Standard Vertical Screw Power Testing Machine (Riehlé Testing Machine Company, Philadelphia, Pa.), of 100,000 pounds capacity, operated by direct connexion to an electric motor, or with a Riehlé Universal Standard Vertical Hydraulic Testing Machine of 50,000 pounds capacity.

Both of these testing machines are in the testing laboratory of the Department of Civil Engineering, School of Mining, Kingston, Ont. The writer wishes to express his thanks to Prof. A. Macphail, in charge of that department, for many valuable suggestions in connexion with the use of these testing machines.

Test Bars.—All bars for tensile strength measurements have been either 'Standard Bars' or 'Proportional Bars', as recommended and adopted by the International Association for Testing Materials. Compression test pieces have been made of circular cross-section ¾″ diameter and 1½″ length.

For each of these determinations the extensibility or ultimate elongation has been measured.

Preliminary Conclusions.—The numerical values for tensile and compressive strength of the pure metal cobalt have as yet not been determined to the same degree of accuracy as they have been for certain of the cobalt alloys. About 5 pounds of metallic cobalt is reduced from the oxide at a time, and a set of observations of the properties of the pure metal made with it. Then it is alloyed with a small percentage of aluminium, chromium, iron, etc., as the case may be, and a series of alloys made and studied with increasing content of the second metal. In this way each batch of cobalt yields a large number of sets of measurements of the properties of its alloys, with but a singular set for the pure metal.

The mean of 15 compression and tensile strength measurements shows these constants for pure cast cobalt to be extremely high. Until a complete publication of these data is made no specific figures will be given, but it is not improbable from the work thus far that the tensile and compressive strengths of pure cast cobalt are higher than the corresponding strengths of any of the ordinary pure metals.

As far as possible strength tests will ultimately be made on rolled and drawn pieces as well as on castings, both for the pure metals and for the alloys.

ELECTROPLATING METALLIC COBALT.

A series of experiments was performed on the electro-deposition of metallic cobalt to compare it with that of nickel. A variety of electrolytes were used and the effect of varying current densities and electro-motive-forces studied. In a general way cobalt may be plated from an alkaline solution in very much the same way that nickel is commonly plated. A current density of 15 milliamperes per square centimetre, or lower, gives a brighter and more uniform deposit than current densities higher than this value.

The details of polarizing electro-motive forces, efficiencies at different current densities, as well as curves showing the nickel-cobalt alloy obtained, plating from different mixtures of $CoSO_4$, $NiSO_4$, and NH_4SO_4 will be published independently.

In general it may be said from the results thus far obtained that cobalt may readily be plated, yielding a surface very similar to that of nickel but somewhat tougher, more silvery in appearance, and more non-corrosive. We have plated nickel-cobalt alloys which appear to be extremely tough and which, therefore, are of commercial interest to the electrotyper. The writer has considered this matter carefully with some of the large electroplating concerns, and arrangements are being made to have tests made on a commercial basis.

COBALT CHROMIUM ALLOYS.

Certain alloys of cobalt and chromium are known to be extremely hard and certain of them to be extremely acid resisting. Mr. Elwood Haynes has recently performed some experiments at Kokomo, Ind., on alloys of cobalt, chromium, tungsten, and molybdenum. He described this work before the Eighth International Congress of Applied Chemistry, at which time he gave the comparative efficiencies of lathe tools made with tool steel and with his alloys. He claims that a tool of one of these alloys turned 49 cast iron wheels in 10 hours, whereas his best steel tool turned only 26 wheels in the same time. 'The steel tool was ground 50 times during the operation, while the edge of the alloy tool was dressed slightly by a carborundum whetstone after a day's work was completed.' Again he says: 'A set of steel cutters placed in the boring head of a cylinder boring machine were able to bore 26 to 28 holes in 10 hours. These cutters were replaced by others made of a cobalt-chromium alloy which performed the work in 3 hours 20 minutes or in a little more than one-third the time.' A number of statements as striking as these are made which are most worthy of confirmation. Obviously, an infinite series of cobalt-chromium alloys may be prepared, the more so if we consider the addition of a third or pos-

sibly a fourth element. Therefore, apart from checking the statements made by Haynes, it seems important to study a number of the alloys of this promising series which have not been examined by him.

Materials.—The chromium used in preparing the cobalt chromium series of alloys was obtained from the Goldschmidt Thermit Company, and analysed as follows:—

Chromium	99·2
Silicon	0·25
Iron	0·50
Aluminium	0·45
Sulphur	0·10

The cobalt was prepared in the laboratory by carbon monoxide or carbon reduction as described above under metallic cobalt.

Alloys.—About 20 alloys have been prepared ranging from a few per cent to 30 per cent of chromium, and the series is not yet completed. These alloys will ultimately be studied under the following headings, and for many of them the work is already well advanced.

(1) Melting point.
(2) Casting properties.
(3) Turning, rolling, and forging properties.
(4) Hardness.
(5) Tensile strength.
(6) Compressive strength.
(7) Corrosion in acids and the atmosphere.
(8) Structure as determined by microphotographs.
(9) Thermo-electric power.

Furnace.—The cobalt chromium alloys were prepared in an electric crucible furnace of the carbon plate resistor type. This furnace could be maintained at any temperature from 1000°C. to 1800°C. and absorbs up to 25 KW.

Melts and Castings.—Weighed amounts of cobalt and chromium were charged into the furnace in a graphite crucible lined with alundum cement. After the metals were melted and well mixed, these alloys were allowed to soak for about one-half hour at a temperature from 50° to 100° C. above their melting point. From this temperature the melts were poured both into sand and iron moulds. In general the lower the temperature of pouring above the melting point the freer the alloy from occluded gases. Neither skim gates nor risers were found to be necessary with these cobalt-chromium alloys, and sound bars 1 foot in length and 1 square inch in section were readily cast, using a very little manganese as a degasifier.

Series of Alloys.—Subsequently a publication will be made of the properties of the entire series of alloys, beginning with pure cobalt and passing in steps of a few per cent of chromium to alloys of such high chromium content that they are too brittle to be of any possible service. A large number of these have already been prepared and studied and the indications are that those in the range between 75-85 per cent cobalt are best suited for the preparation of metals for cutting tools. Additions of small percentages of molybdenum, tungsten, manganese, and phosphorus are being studied, and are being found to add to the hardness and to the working properties of these cobalt-chromium alloys. Cochrome wires are being compared with the well-known "nichrome" wires.

Until the observations are more complete, no final nor general conclusions will be drawn, but some individual values, taken more or less at random from a large number, are here given to indicate the extreme properties of these alloys.

Hardness.

Sample No.	Composition.	Pouring and casting.	Brinell hardness.	
H 55.......	Co 70%, Cr 29%, Mo 1%.	Poured at 1640°C., iron mould, manganese degasifier.	Mean of four observations. Load 3,500 lbs.	229
H 19..	Co 77·5%, Cr 22·5%.	Poured at 1640°C........................	Load 3,500 lbs.	225
H 56. .. .	Co 69%, Cr 29%, Mo 2%.	Poured at 1640°C., iron mould, manganese degasifier.	Mean of five observations. Load 3,500 lbs.	203
H 57...	Co 74%, Cr 24%, Mo 2%.	Poured in iron mould, cooled slowly, ferro-silicon addition, 0·2%.	Mean of six observations. Load 3,500 lbs.	194

These figures show these alloys to be considerably harder than the best tool steel. On account of this extreme hardness it was found impossible to turn them with lathe tools, and castings were shaped by grinding with carborundum wheels.

Attempts were made to influence the hardness of these alloys by heat treatment, but as yet it has not been found possible to soften them by annealing or to increase their hardness by quenching either in water or other reagents.

Lathe Tests.—While the alloys of this series thus far made and tested are not as good as those being made at present, so that it is early to draw definite conclusions, nevertheless, the indications are that these alloys will suffer from their lack of ability to yield to heat treatment. The tools thus far made compare favourably with the best untreated tool steels, but as yet they do not lend themselves to heat treatment and do not compare favourably with the best tempered tools or with good self-hardening steels.

Working and Rolling Properties.—A number of these alloys have been forged, both cold and hot, and a few samples have been sent to the rolling mills to test the possibility of working them.

In this connexion the writer wishes to express the thanks of this laboratory to the Montreal Rolling Mills Company, of The Steel Company of Canada, Limited, and in particular to Mr. H. R. McMaster, Manager, for their extreme willingness to co-operate in making these tests, and for a certain number of rolling tests already made.

In general, the samples thus far forged and rolled may be said to be hot short. It has been possible to forge them to shape for cutting tools if care were exercised not to raise the temperature beyond a dull red. The rolling experiments have thus far been made at a somewhat too high temperature but further samples will be tested in the near future.

Strength Tests.

Sample No.	Composition.	Pouring, casting, and heating treatment.	Tensile strength.
H 19 A.....	Co 78%, Cr 22%	Cast in sand mould at 1600°C............	94,800 lbs./in².
H 38 A	Co 10% Cr 19·8%, Mn 0·2%	Cast in sand mould in form of test bar....	95,000 lbs./in².

The elastic limit of some of the specimens was as high as 60,000 pounds per square inch.

Although, as mentioned above, these specimens are not as good as those now being made, nevertheless, both the elastic limit and the tensile strength are superior to that for untreated steel and are about that of the standard specifications of the American Society for Testing Materials for structural nickel steel for buildings.

No doubt the sulphur content of these alloys, often running to nearly 0·2 per cent, is responsible for the rolling and forging difficulties. We are at present at work to eliminate this sulphur.

Corrosion in Acids and the Atmosphere.—In order to determine the relative resistance of metals and alloys to chemical reagents and the atmosphere, that is to determine their passivity, a great variety of standards may be adopted. Ultimately we shall, of course, make those passivity tests which appear most intimately to involve the purpose for which the alloy is intended in industrial use. As an immediate standard of comparison for use in this laboratory the following is extremely useful and has been adopted.[1]

As a standard of acid, nitric acid specific gravity 1·42, ratio of one of acid to three of water, making approximately 25 per cent or 4 N solution of nitric acid, is used. A sample of metal is finished to have smooth surfaces of such shape that its exposed area may readily be computed. It is then subjected to the action of the acid for 24 hours at room temperature. The particular measure of passivity adopted is the loss of weight of the sample under these conditions per 100 square centimetres of exposed surface per hour of exposure.

As a result of experiments of this sort, the following values are given with which to compare the corresponding measurements with the new alloys.

Relative Solubility of Metals and Alloys in 25 per cent Nitric Acid.

Substance.	Milligrams dissolved per 100 sq. cms. surface, per hr. at room temperature.
Pure iron, 99·8 pure	30·0
Commercial aluminium	15·6
Nickel sheet	13·1
Monel metal	6·35
Nichrome, Ni 90%, Cr 10%	2·38
Ferro-silicon	0·0300

To compare with this table, the solubility of an alloy cobalt 78 per cent, chromium 22 per cent, in 25 per cent HNO_3, is 1·47 mgs. per 100 sq. cms. per hour. All the cobalt chromium alloys from 15 per cent to 30 per cent Cr are of this order of extreme passivity.

ALUMINIUM-COBALT ALLOYS, AND ALUMINIUM-COBALT-COPPER ALLOYS.

In discussing the requirements of the market with some of the larger foundrymen, the writer has repeatedly had it emphasized to him that there is an urgent need in many quarters, particularly among automobile manufacturers, of an alloy of aluminium which shall not be very much heavier than the present alloys largely used, but which shall have increased tensile strength, and which shall not be subject to the same degree of shrinkage in casting.

[1] This standard has also been used by Parr, J. Industrial and Engineering Chemistry, Nov., 1912, page 844.

I note 53 alloys of aluminium, principally copper-aluminium alloys, which are at present in use; easily 90 per cent of all the castings of this series used in automobile construction are of the composition aluminium 92 per cent, copper 8 per cent. This particular alloy has a tensile strength of about 20,000 pounds per square inch, and shrinks badly in casting.

The tensile strength of the light casting alloys of aluminium is tremendously influenced by the size of the constituent crystals, that is, "by the closeness of the grain." For any given composition the finer the grain that can be produced the stronger the metal. The closeness of the grain of these alloys is greatly affected by:—

(*a*) Small additions of other elements.
(*b*) The volume and dimensions of the casting.
(*c*) The temperature and heat conductivity of the mould.
(*d*) The temperature at which the metal is poured into the mould.

The extreme industrial importance of these alloys, as well as the fact that certain preliminary experiments made it appear that satisfactory results might be expected, has caused us to undertake the investigation of the effect of adding various proportions of cobalt to aluminium and to copper-aluminium alloys. Since commencing this work a German patent, by W. Borchers and Herman Schirmeister, Aachen, which was issued in January, 1912, has come to hand. We are finding, in keeping with this patent, that additions of from 8-10 per cent of cobalt, and in the neighbourhood of 1 per cent of tungsten or of molybdenum, yield alloys which are more readily worked and finished, and which are more non-corrosive than pure aluminium.

Beyond this patent there seems to be nothing in the literature pertaining to this series, but in any event, the factors which determine the ultimate valuable properties of such an alloy are so numerous that there is offered a most promising field for a great variety of investigations.

Starting with pure aluminium, alloys are being prepared with increasing percentages of cobalt, and as well, a great variety of aluminium cobalt-copper alloys are being cast and studied. The effect of both tungsten and molybdenum in small percentages is also being tried. Determinations are being made under the various headings enumerated under cobalt-chromium alloys.

Great difficulty has been experienced in obtaining these castings free from occluded gases, and it is only during the last weeks, after pouring some 100 castings, that the technique has become sufficiently well in hand to promise representative results. Consequently a report of the numerical constants of this series will be deferred until later, at which time the entire series will be treated in an independent publication.

COBALT BRONZES.

We have prepared a number of cobalt bronzes similar to the well known chromax bronze, substituting the nickel content with cobalt. These bronzes are substantially of the following composition.

Copper	66·66	per cent.
Tin	12·13	"
Cobalt	15·15	"
Chromium	3·03	"
Aluminium	3·03	"

Also some variations in these ratios have been tried. This particular alloy with 15·15 per cent cobalt is found to be somewhat harder, but of slightly less tensile and compressive strength than the corresponding nickel compound. The cobalt bronze is a beautiful metal which can be readily cast and turned. A number of bronzes with considerably higher cobalt content are being studied.

NON-CORROSIVE ALLOYS.

Apart from the cobalt-chromium alloys, the acid resisting properties of which have already been noted under the heading "Cobalt-Chromium Alloys," there are certain cobalt-tin alloys and cobalt-copper-tin alloys which are extremely passive. Alloys containing 80 per cent to 95 per cent copper, 12 per cent to 3 per cent tin, 8 per cent to 2 per cent cobalt, have been and are being prepared, and passivity tests made according to the procedure outlined under the headings "Cobalt-Chromium Alloys," "Corrosion in Acids and The Atmosphere."

During the progress of the experiments on cobalt-tin alloys, a paper has come to my attention entitled "Die Erhöhung der chemischen Widerstandsfähigheit mechanisch noch gut bearbeitbarer, für Konstruktionszwecke verwendbarer Legierungen," by Otto Barth, Metallurgie 1912, page 216, in which the author discusses alloys containing cobalt and tin in the ratio of 4 to 6 as being particularly non-corrosive. The series of cobalt-copper-tin alloys with small additions of other elements are being studied in some detail. The alloy 40 per cent Co and 60 per cent Sn, without further addition, was prepared and found to be practically insoluble in all concentrations of nitric acid. However, this particular alloy is so brittle that it is worthless for most purposes. We are experimenting to better the working properties of this alloy without too greatly diminishing its passivity.

The writer has had a number of inquiries from prominent chemists and engineers with regard to these non-corrosive alloys, and a study of their properties in chemical reagents other than acids is being planned.

MAGNETIC ALLOYS.

One of the first matters considered upon the establishment of this laboratory was the possibility of preparing alloys of cobalt and iron which should have a greater magnetic permeability than the best iron now in use for electromagnetic apparatus. The discovery of such an alloy, having working properties capable of rendering its use possible, either for the construction of electro-magnetic machinery or of small measuring instruments, would, of course, be of tremendous importance.

Our experiments indicate that the alloy of such proportions as to yield the compound Fe_2Co, has a magnetic permeability about 10 per cent greater than that of the best magnetic soft iron. Due to the difficulties of obtaining a suitable pure iron for experimental purposes, and due to delays in obtaining certain auxiliary apparatus, fuller observations on these cobalt-iron magnetic alloys, such as to establish their permeability, have not yet been made. This work will be completed in the near future, and a corresponding independent publication made.

COBALT STORAGE CELLS.

Experiments are being planned and have already been begun to study the effect of substituting cobalt and cobalt-oxide for nickel and nickel-oxide in the new Edison storage cell.

COBALT AS CATALYSER.

Patents have recently been issued in the United States to Mr. E. C. Kayser, for the use of finely divided nickel, rendered non-pyrophoric and stable in the air by the action thereon of CO_2 gas at high temperatures, for use as a catalyser for various chemical processes. Experiments are being undertaken to determine the comparative values of cobalt and nickel for these purposes.

At various times in connexion with other experiments in this laboratory we have had indications which lead us to believe that finely divided cobalt may prove to be an extremely active chemical catalyser.

MICROPHOTOGRAPHS.

In keeping with the modern trend, microphotographs are being taken of all the more important alloys as we prepare them. These serve to visualize the characteristics of the alloys in terms of their ultimate physical structure and a number of them will be published in their appropriate places with the more complete publications.

These photographs are being taken with the most modern and complete Leitz Micro-Metallograph.

POWER SUPPLY OF LABORATORY.

This laboratory is at present supplied with alternating current, 30 cycles, 2200 volts, 75 KW. from the central power plant of the School of Mining. A new engine and generator are nearly complete and are to be installed in the immediate future, upon the installation of which this laboratory will have at its command at all times alternating current, 30 cycles, 2200 volts, up to 120 KW.

This power, which enters the building at 2200 volts, is transformed down so that it is available for use in steps of about 5 volts, from 15 volts to 120 volts. The secondary coils of the step down transformer are connected to a switchboard in such a way that any of these voltages may be supplied from the switchboard to bus-bars running to either side of the laboratory. The furnaces are direct connected to these bus-bars by suitable cables, and with suitable current transformers to govern the measuring instruments.

The writer wishes to acknowledge the work of Calvin W. Day, B.Sc., M.A., Charles Harper, B.A., W. L. Savell, B.Sc., and F. G. Daly, to whom, in the capacities of research assistants and associates, a large part of the actual experiments in connexion with these researches is due. The fact that such rapid progress has been made in getting these researches thoroughly under way in so short a time, is almost entirely due to the untiring enthusiasm and splendid spirit of these gentlemen.

The writer wishes to point out particularly, as has been done in the body of the report for certain parts of the work, that this paper is in no sense a complete or final publication of these researches. It is rather an outline of what we are doing, with sufficient detail to show the general trend of the work and to indicate the very considerable importance of what may be expected in the near future.

II.

RECENT DEVELOPMENTS IN THE ELECTRO-THERMIC PRODUCTION OF IRON AND STEEL, 1911-1912.

The iron and steel industry of central Canada has always been dependent upon imported coke and coal. Here the conditions which prevail over large areas, resemble to some extent those which obtain in Sweden, Italy, and California. In these latter countries, there is an abundance of iron ore and limestone, and undeveloped water-powers, while coal and coke command a comparatively high price. Therefore, everything which pertains to the production of iron and steel through the development of hydro-electric power, is of interest and importance to Canada.

Experimental investigations to test the possibility of directly smelting iron ores in an electric furnace were carried on by the Canadian Government,[1] as early as 1905. Of late, however, the extension and completion of that work, with the object

[1] Report on the experiments made at Sault Ste. Marie, Ont., under government auspices in the smelting of Canadian iron ores by the Electro-Thermic Process, Eugene Haanel, 1907. Mines Branch, Department of the Interior, Canada.

of deducing industrial conclusions, has been conducted in Sweden and California. The publications of the Mines Branch, Department of Mines, Canada, have reported the progress of this work up to the year 1910; the present paper is a review of the more recent developments from that date to the present time.[1]

Earliest Comparisons of Electric and Blast Furnaces.—The pioneer work in connexion with the production of pig iron by direct smelting of Canadian iron ore, was that of the Commission appointed by the Canadian Government and reported upon by the Superintendent of Mines in 1904. A final report by Dr. Eugene Haanel on the "Experiments made at Sault Ste. Marie, Ont., under Government Auspices in the Smelting of Canadian Iron Ores by the Electro-Thermic Process," was published in 1907. In this report the electric furnace and the blast furnace are compared, and in a general way the conclusions are summarized by the following sentence taken from the report[2]: "Yet with even these drawbacks the blast furnace of to-day, representing the result of one hundred years experience and inventive skill, must be pronounced a perfect machine, hardly permitting further improvement, and if the electric furnace, which is yet in its infancy, is able in its present state of development to compete with the blast furnace under the special conditions of cheap electric energy and high price of metallurgical fuel, what may we not expect of its performance when all the calories available in an electric furnace will have been utilized by proper design, as the result of years of experience?"

First Swedish Electric Furnace Operation at Domnarfvet.—Encouraged by the data published by the Canadian Commission on the electro-metallurgy of the reduction of refractory ores without the use of coke or coal fuel, the Swedish engineers, Messrs. Groenwall, Lindblad, and Stalhane, undertook to extend the investigations on a larger scale. Within the last few years the price of charcoal in Sweden has doubled, so that manufacturers there are facing the necessity of giving up the manufacture of charcoal iron. They could not import coke, for such fuel would bring their pig iron in direct competition as regards quality, with the rest of Europe. Therefore, the principal thought of these engineers was to save the industry by utilizing electrothermic methods, in which only about one-third as much fuel is required per ton of iron as in the blast furnace. That is, with a limited supply of charcoal it is possible to get approximately three times as much pig iron from electric furnaces as from blast furnaces. As a result, experiments were undertaken with an electric shaft furnace at Domnarfvet, Sweden, beginning in April, 1907, a full account of which has been published in the various metallurgical journals.

Canadian Government Investigation of Electric Furnace at Domnarfvet.—A special investigation with the Domnarfvet furnace was made early in 1909 by Dr. Haanel for the Canadian Department of Mines.[3]

This investigation was intended to elucidate the following points:—

(1) Whether undisturbed and uniform working without troublesome regulation of the electrodes could be obtained.

(2) Whether great variations in the consumption of energy would occur.

(3) Whether the free spaces within the melting chamber would be maintained with the shaft considerably higher than in the furnace of earlier design and construction.

(4) Whether the contraction of the shaft would prevent the charge from sinking uniformly, or cause hanging.

---

[1] The writer has noted in the text the various publications from which most of the facts of this article have been taken.

[2] Report on the experiments made at Sault Ste. Marie, Ont., under government auspices, in the smelting of Canadian iron ores by the Electro-Thermic Process, Eugene Haanel, 1907, Mines Branch, Department of the Interior, Canada, page 95.

[3] Report on the investigation of an electric shaft furnace at Domnarfvet, Sweden, Mines Branch, Department of Mines, Canada, 1909.

(5) The durability of the arched roof, and the possibility of cooling it by means of the circulating gas.

The report was generally favourable on each of these points.

Conclusions from Domnarfvet Operation.—At the conclusion of the tests at Domnarfvet, May 7 to July 30, 1909, Mr. Lars Yngström[1] summarized the advantages of the electric shaft furnace over the ordinary blast furnace as follows:—

(1) Lower cost of installation, since blowing engines and hot blast stoves are not required.

(2) Saving of about two-thirds of the fuel required in an ordinary blast furnace.

(3) Ore dust could be used without briquetting.

(4) The gases evolved have a high value, being free from nitrogen.

(5) The possibility of producing low carbon iron.

(6) Less attendance, principally due to the elimination of transportation and charging of two-thirds of the fuel.

The general conclusions from all the work at Domnarfvet, seem to be that the production of iron from iron ore in electric furnaces is successfully accomplished both technically and economically under the conditions governing those tests. Further, that the experiments should be continued on a larger scale, and that in any case an essential pre-requisite for the commercial success of the process is sufficient available electrical energy at a low price.

Problem of Electro-Thermic Iron Attacked by Jernkontoret. Points of Investigation.—The Jernkontoret (Swedish Association of Iron Masters) realizing the extreme importance of electro-thermic pig iron to Sweden, and encouraged by the work at Domnarfvet, arranged for the expenditure of about $90,000 for further investigation. This was undertaken at Trollhätten, Sweden, under the direction of the engineers, J. A. Leffler and E. Nystrom. The most important points to be investigated at the Trollhätten plant were the proper height of the furnace and the dimensions most suitable for various charges; the most suitable design and manner of construction; the shape, arrangement, and consumption of electrodes; the electrical energy and fuel consumption per ton of iron of certain composition; the means and the effect of circulation of gases; the possibility of production of pig of various compositions; the conduct of various charges and concentrates, and the influence of the same on economy; the value of the escaping gases, the efficiency of the furnace; and the maintenance cost at the furnace.

Jernkontoret Plant and Furnace at Trollhätten.—The first operation of this furnace was for a period of nearly five months of continuous working between November, 1910, and May, 1911, and was reported upon at length by Mr. Leffler at the meeting of the Jernkontoret, May 31, 1911. These observations and those subsequently made and reported upon will greatly serve the industry, as they have been made under almost ideal conditions, using the very best instruments and under the supervision of a highly efficient staff of engineers.

The plant is located at Trollhätten on ground owned by the Swedish Government, and suitable railway tracks were laid for transportation of ore and fuels. A complete description of the plant, including storage houses, crushing machinery, and furnace houses has been published,[2] as well as a description and drawings of the shaft, the crucible, and of the furnace parts.

---

[1] Jernkontoret Annaler, 1909.
Also Bulletin No. 3, Mines Branch, Department of Mines, Canada, 1909, page 19.

[2] Mr. Leffler's report.
Metallurgical and Chemical Engineering, Vol. 9, page 368, 1911.
Stahl and Eisen, 1911, page 1010.
Transactions American Electrochemical Society, XX, page 375, 1911.

Fundamental Principles of the Trollhätten Reduction Furnace.—The fundamental principles of the construction of the Trollhätten furnace are described in a communication from the Electro-Metals Ltd., London, England, as follows:—

I. As all known materials become good conductors at a high temperature, the construction must be such that the current does not pass through the lining during the working.

II. The construction must be such that the charge itself protects the lining from destruction through radiation from the electric arc or through conduction; otherwise it would be necessary to employ water-cooling with consequent waste of energy.

III. The charge must not press harder against the electrodes than to permit the formation of an arc. If this condition is not fulfilled the working becomes irregular, the resistance becomes unduly low, so that the electrodes and conductors would have to be of unreasonably large dimensions.

IV. In an electric furnace the carbon charged with the ore cannot burn, and in order to obtain a product of uniform quality it is, therefore, necessary to have a hearth of sufficiently large dimensions to serve as a mixer. Otherwise, every irregularity which inevitably occurs in charging, will influence the carbon content of the product.

In order to fulfil these conditions the hearth is constructed in the shape of a comparatively large crucible covered by an arched roof. When the charge sinks down into the crucible it spreads in such manner that a free space is always formed between the charge and the brickwork of the roof. The electrodes are introduced into the crucible through the brick-work at points where it is not in contact with the charge, and they penetrate the charge through its free exposed surface. By means of this construction the above enumerated conditions 1, 2, and 3, are fulfilled, and as the hearth can be made comparatively large, condition 4 is also fulfilled.

The Principles Employed for Calculating the Form and Dimensions of the Shaft.—The form and dimensions of the shaft were computed on the basis of manufacturing 23 tons of pig per 24 hours. In Mr. Leffler's report[1] the assumption upon which the calculations were based and the methods of computation are given in detail. The diameter of the neck of the shaft was fixed at 120 centimetres and the depth of the crucible determined as a result of experience at Domnarfvet. The computation showed that 25·55 cubic metres of effective shaft volume were required, and it was finally proportioned such that the total height of the furnace from the bottom to the top was 12·7 metres.

Mr. Leffler notes in his report[2] that the height and the other dimensions of the shaft in the main proved correct for normal conditions of fuel and ore. If, however, earthy ore concentrates or too fine fuel are used, or if the charge contains too much moisture, the working is injuriously affected, as would equally be the case with an ordinary blast furnace, and the design of the shaft does not appear to be well suited for such conditions.

Circulation of Gases.—One of the features of this furnace, is the appliance for the circulation of the gases from the stack, which are drawn by means of a fan and blown into the crucible under the roof. Consequently the quantity of gas passing any given section of the shaft can be varied within certain limits by varying the speed of the fan. This circulation of gas fulfils two special functions:—

(1) The gas blown into the crucible absorbs heat which it discharges to the charge in the shaft during its upward course. Through this heat a reduction of the ore by CO is facilitated, so that this gas is utilized to some extent for the process.

---

[1] Jernkontoret Annaler, May 31, 1911.
Also, Metallurgical and Chemical Engineering, Vol. 9, page 368, 1911.
[2] Metallurgical and Chemical Engineering, Vol. 9, page 461, 1911.

(2) The gas blown into the crucible under its roof cools the latter, thus protecting it from over heating and increasing its life. The cooling action is in part due to direct absorption of heat energy to raise the temperature of the gas, and in part due to an absorption of heat energy to bring about a decomposition of CO_2 and H_2O in contact with incandescent carbon of the crucible.

This gas circulation is a special feature of the Trollhätten furnace, and whatever other advantages it may supply, obviously it tends to lower the temperature of the reacting charge. This may be the cause of the apparent increased sulphur content of some of the pig, to be spoken of subsequently.

In order to produce an effective and uniform circulation of the gas, it must be purified by washing so that frequent interruptions for cleaning may be avoided. Further, the gas pipes and the crucible must be quite tight, so that the gas drawn by the fan is really blown into the crucible. The gas circulating equipment was not satisfactory as operated during the first five months at Trollhätten, but was improved before the second smelting campaign.

Another result of the circulating gas is to blow large quantities of CO_2 gas against the carbon electrodes, thus attacking them severely. However, the electrode consumption has not been excessive, the average for the entire five months being 10·28 Kg. gross and 5·27 Kg. net,[1] per ton[2] of iron.

There has been considerable discussion as to the merits of this gas circulating arrangement. Dr. J. W. Richards recommends that the artificial circulation of the gas be entirely dispensed with and that the arch of the crucible of the furnace be protected with water cooled plates as is common in open-hearth furnaces.[3] As will be discussed later, this is the method practised in the electric pig furnace at Heroult, California.

Fuel.—Apart from the small quantity of coke used for starting the furnace, charcoal has been used exclusively for the reduction. The average composition for the charcoal is[4]:—

Water	14·58	per cent.
Gases	10·26	"
Ash	3·06	"
Fixed C	72·10	"
Carbon	87·95	"
Hydrogen	2·60	"
Nitrogen	0·15	"
Oxygen	0·61	"

During the five months covered by Mr. Leffler's first report, November 15, 1910, to April 9, 1911, the average consumption of charcoal per ton of iron was 920 pounds.

Ore and Limestone.—During the five months twenty-nine different qualities of charge were used. Following are a few analyses of the limestone and ore.[5]

Limestone from Gasgrufvan.—CaO 54·32 per cent, Fe_2O_3 0·24 per cent, MnO 0·35 per cent, MgO 0·31 per cent, SiO_2 1·68 per cent. Loss on ignition 42·94 per cent.

Iron Ore from Tuolluvaara.—Fe_3O_4 91·05 per cent, Fe_2O_3 1·41 per cent, MnO 0·16 per cent, MgO 1·12 per cent, CaO 0·28 per cent, Al_2O_3 0·16 per cent, TiO_2 0·10 per cent, SiO_2 3·42 per cent, P_2O_5 0·050 per cent, S 0·011 per cent.

Iron Ore from Langban.—Fe_2O_3 89·85 per cent, FeO 2·49 per cent, MnO 0·18 per cent, MgO 0·85 per cent, CaO 0·99 per cent, Al_2O_3 0·42 per cent, SiO_2 5·08 per cent, P_2O_5 0·014 per cent, S 0·007 per cent.

[1] Metallurgical and Chem. Eng., Vol. 9, page 508, 1911. Also Transactions Amer. Electro-chemical Soc. XX, pp. 385, 1911.
[2] Throughout this paper all tons are metric tons of 2,200 pounds.
[3] Metallurgical and Chemical Eng., Vol. 10, page 290, 1910.
Also, Trans. American Electro-chemical Society, XXI, page 407, 1912.
[4] Metallurgical and Chemical Engineering, Vol. IX, page 462, 1911.
[5] Metallurgical and Chemical Engineering, Vol. IX, page 462, 1911.

During the time to which the report refers only unburned limestone has been used. Mr. Leffler notes, however, that by the use of burned limestone, if it were possible to do so, the economy of the process would be improved. This modification will be considered later.

Whether unburned or burned limestone is used, the percentage of CO_2 in the gas remains the same. This proves that the CO_2 derived from the limestone is replaced by CO_2 developed by the reduction of the ore by CO. That is, the power required for burning the limestone is saved and the same quantity of fuel reduces more ore.

Electrodes and Electrode Consumption.—The electrodes were of carbon; part were supplied by the Plania Werke, Ratibor, Silesia, and part by the local Swedish companies. No difference in durability could be discovered in these electrodes, but the local ones ran somewhat higher in sulphur. Each electrode of the furnace was built up of four carbons, two metres long and 33 × 33 centimetres in cross section, arranged to form an electrode of 66 × 66 centimetres cross section. The average working time of ten electrodes was 906 hours[1] each, and the average consumption during the five months per ton of iron was 10·28 Kg. gross or 5·27 Kg. net. That is, only 51 per cent of the length was consumed as electrode. Experience with the Trollhätten furnace appears to indicate that the four electrodes used are the minimum number which would be satisfactory. It would probably be better to use six electrodes, three phase. This would distribute the heat more uniformly, and the risk of disturbances due to defects in the transformers would be reduced.

Power Consumption.[2]—Mr. Leffler's report[3] gives tables of the ore used, together with limestone, charcoal, electrode consumption and power for the respective charges, and also the amount of pig iron and slag produced from the various groups of charges. The average actual power consumption, for one ton of pig was 2391 KW. hours. If the power were fully utilized during the 8760 hours of the year, this corresponds to 2·69 tons per H.P. year.

These figures are only strictly applicable in the case where electric reduction furnaces will obtain electric power on such a basis that they only pay for the actual amount of power used, and will require modification where electrical energy will have to be paid for at a fixed price per year for a certain amount of maximum available power.

The Durability of Crucible and Roof.—The roof of the crucible was thought at the outset to be the weak point in the construction of the furnace, but it stood up during these five months of operation in an excellent manner, only two repairs of any importance having been necessary. That is, during a period of nearly five months of continuous working, only about eighteen hours were required for repairs. This must be recorded as an eminently satisfactory result.

In the neighbourhood of the electrodes the arch became red hot in places after protracted working, but it generally became possible to prevent the bricks from burning through by cooling them with an air blast. On one occasion, when the charge contained 70 per cent of concentrates, a settling occurred from the shaft into the crucible which was accompanied by such a violent evolution of gas that the roof was damaged between the electrodes. Repairs were effected within less than two hours.

Iron and Slag.—In the references already cited, complete tables are published showing the continuous working of the furnace and giving analyses of the iron, slag, and gas at very frequent intervals. The accompanying table is the average of all the analyses from January 3, 1911, to January 30, 1911.

---

[1] Metallurgical and Chemical Engineering, Vol. IX, page 507, 1911.
[2] Stahllund Eisen, 1911, page 1010.
[3] Metallurgical and Chemical Engineering, Vol. IX, page 505, 1911

Average analyses of iron:—

Carbon	3·2 per cent.
Silicon	0·3 "
Manganese	0·3 "
Sulphur	0·028 "
Phosphorus	0·015 "

Average analyses of slag:—

SiO_2	43·00 per cent.
Al_2O_3	5·00 "
TiO_2	3·00 "
FeO	2·00 "
MnO	2·00 "
CaO	30·00 "
MgO	15·00 "
CaS	0·050 "
Si	1·60 "

SECOND REPORT OF OPERATIONS ON TROLLHÄTTEN FURNACE, COVERING PERIOD FROM AUGUST 4, 1911 TO MARCH 6, 1912.[1]

As has been pointed out above in reviewing the first report, alterations were to be undertaken to make the gas circulation more effective and uniform, and to reduce the consumption of electrode per ton of iron. The changes considered necessary for this double purpose were effected. Obviously a further improvement would have been made by the installation of six electrodes instead of the four hitherto used, but this would have entailed so much delay and additional expense that it was abandoned.

Accordingly, the second campaign was instituted which was continued without serious interruption from August 4, 1911 to March 6, 1912. Mr. Leffler has issued a second report covering this period.[2]

Circulating Gas.—The improved arrangements for circulating and purifying the gas, have been found to be satisfactory; the clogging of the fan previously experienced is now a thing of the past.

Electrodes and Electrode Consumption.—Round electrodes instead of square ones were adopted, a modification which necessitated considerable alteration. These electrodes were formed of sections joined together by screws let into their ends, whereby they could be fully consumed. The result was very satisfactory and the electrode consumption was reduced from 10·28 kilograms per ton of iron, during the period from November 15, 1910, to April 9, 1911, to 5·18 kilograms per ton of iron, which figure is the average consumption for the entire period from August 4, 1911, to March 6, 1912.

For the most part the electrodes were 60 centimetres in diameter, and contained 0·022 per cent phosphorus, 0·85 per cent sulphur, and 4·15 per cent ash. A high percentage of CO_2 or of H_2O in the circulating gas increased the consumption of the electrodes very materially.

Power and Charcoal.—In the run which was most studied and which 'rendered such good results that it will not be easy to improve upon them,'[3] 74·39 per cent of the electrical energy, measured at the high voltage side of the transformers, was effectively utilized in the smelting process. Mr. Leffler notes that efficient distribution of the gas is essential for this economy. The average power consumption for

[1] Stahl and Eisen, 1912, page 1409.
Also Engineering, September, 1912, page 395.

[2] Many of the points with reference to this second run are taken from Engineering, Vol. XCIV, page 395, 1912, which covers the ground of Mr. Leffler's report.

[3] Engineering, Vol. XCIV, page 395, 1912.

this period was 3·92 tons per H.P. year, as against 2·69 tons per H.P. year for the previous runs. Corresponding with this, the consumption of charcoal has dropped from 920 pounds per ton of iron, which is the average for the first campaign, to 670 pounds per ton of iron during this latter campaign.[1]

Thus the charcoal consumption for this type of furnace is about one-third of that of the ordinary blast furnace. This process substitutes electrical energy for about two-thirds of the fuel charge and the pre-requisite of very cheap power for the economical operation of this process becomes obvious.

Method of Charging. Use of Concentrates.—A special study was made of the proper distribution of the ore relative to the walls of the stack in charging, in order that the ascending gases might do their utmost in the way of reduction, heating, and drying. The result with about 30 per cent of the burden charged into the centre of the furnace seemed to be the best. Mr. Leffler points out in his report, that the sinking of the charge in the shaft was perfectly even with all the charges approximating in composition to the best of these. 'Nor is there any reason to presume that the drawbacks experienced with charges of concentrate could occur during the smelting of a close, fast, fairly roughly crushed magnetite, rich in iron.' Besides the best charge a number of other charges were used to ascertain how much concentrate could be used without interfering with the working and economy of the furnace.

The results of the use of concentrate are fairly well expressed by the following quotation: 'During the former trials dealt with in the previous report, fairly good results had been obtained by using as much as 50 per cent raw Persberg concentrate and 32·5 per cent raw Kanalgrufoe concentrate, whilst, on the other hand, charges with 40 per cent Klacka-Lerberg concentrate had proved a failure. This failure was attributed to moist concentrate having made its way into the smelting-chamber, and there causing a violent outburst of steam. That was no doubt the case, but during the last experimental period it has been found that even if the concentrate is dried prior to being used, caution has to be exercised in its use on account of other difficulties connected with it.'[2]

The causes of the difficulty with concentrate are discussed at some length in the articles cited, the principal objection apparently being that the concentrate of extremely small grain tends to form cakes and lumps, thus becoming unevenly distributed through the charcoal, and finally causing a violent reaction as it reaches the arc zone.

THE DEVELOPMENT OF THE ELECTRIC REDUCTION FURNACE IN CALIFORNIA, U.S.A.

During the time that these important experiments were being conducted in Sweden, a similar set of experiments were under way at Heroult, California, under the general direction of the management of the Noble Electric Steel Co. Complete accounts of the operations at Heroult have never been published, but a very recent paper by Mr. R. W. Van Norden[3] on 'Electric Iron Smelting at Heroult, Cal.,' gives a general review of their work. Many of the points to be mentioned in this paper concerning the furnace at Heroult, are noted from Mr. Norden's article.

Mr. D. A. Lyon[4] notes that due to Dr. Heroult's connexion with the experimental work which had been done by the Canadian Government at Sault Ste. Marie, he was commissioned to construct a plant for the electro-thermic treatment of the magnetite ores of the Shasta Iron Co. in California. This ore is very pure magnetite having the average composition:—

[1] Metallurgical and Chemical Engineering, Vol. 9, page 507, 1911.
Also, Engineering, Vol. XCIV, page 369, 1912.
[2] Engineering, XCIV, page 396, 1912.
[3] Journal of Electricity, Power, and Gas, November, 1912.
[4] Metallurgical and Chemical Engineering, Vol. 11, page 15, 1913.

Fe	69·90 per cent.
Fe_3O_4	89·4 "
Fe_2O_3	7·3 "
MgO	0·10 "
MnO	0·18 "
SiO_2	2·40 "
P	0·011 "
S	0·009 "

Several types of furnaces were tried, the first having been completed in July, 1907. Later a similar type of furnace was developed simultaneously in Sweden and in California, although neither the Swedish inventors nor those engaged in the work at California knew of the other's work. The development of this type of furnace was continued in California until the spring of 1911.[1] Finally the present type of furnace was developed at Heroult, Cal., this time into a commercial and economic success.

The Furnace.—The crucible is contained in a steel shell 27 feet long by 13 feet wide by 12 feet high. The shell is so lined with refractories that the upper half of the box is rectangular, but in the lower half the sides taper towards the centre of the foundation and the ends slope towards the middle, to facilitate the flow of the molten bath when the furnace is tapped. The roof of the furnace is arched, and opening into it are five stacks through which the charge is conducted into the crucible. In the four spaces between the stacks are inserted four electrodes.[2, 3] The electrode jackets and the arched roof are water-cooled. The stacks through which the ore is charged are 2 feet in diameter and 15 feet high from the roof of the crucible. Except when receiving the charge, the stacks are closed with caps. In this furnace the stacks are only for the purpose of charging, no reduction being attempted in them.

The Electrodes.—Cylindrical graphite electrodes,[2, 3] 1 foot in diameter and 4 feet long, are used. These are threaded so that, as the electrode is fed into the charge, the new one may be fastened to it, making a continuous electrode feed.

Operation of the Furnace.—The operation of the furnace is continuous, the hearth being tapped every eight hours. Charging is done at regular intervals and the current is not shut off at any time.

Charge.—The lime used in making up the charge is well burned. Following is a representative charge:—

500 lbs. iron ore (magnetite).
135–150 " charcoal.
3½ " lime (well burned).
12½ " quartz.

Power, Efficiency, Fuel, Etc.—Mr. Van Norden's article gives information concerning the transformers, electrical connexions, and control. Further facts about the Heroult furnace, particularly concerning its mode of operation, efficiency, etc., will be found below when comparing it with the Trollhätten furnace.

---

[1] Metallurgical and Chemical Engineering, Vol. 11, page 16, 1913.

[2] Metallurgical and Chemical Engineering, Vol. 11, page 16, 1911.

[3] Mr. Frick reports that there are six electrodes, 8½" in diameter. Metallurgical and Chemical Engineering, Vol. 9, page 632, 1911.

Comparison of the California and Swedish Furnaces and Process.

Dimensions of furnaces.	Trollhätten furnace.	Noble furnace.
Maximum power consumption	2500 H.P.	2040 H.P.
Total height of furnace	13·7 metres.	8·3 metres.
Outside diameter of crucible	5·65 "	3·96 "
Outside diameter of shaft	3·2 "	2·8 "
Volume of shafts	25·5 cub. metres.	7·9 cub. metres.
Radiating surface	189 sq. metres.	106 sq. metres.

From these figures it will be seen that the dimensions of the Trollhätten furnace are considerably larger than those of the Noble furnace.

The Shaft.—Mr. O. Frick[1] and Mr. Leffler[2] entered into a discussion as to the proper size of the shaft. As will be pointed out, the Trollhätten and the Heroult furnaces are making different products, and no doubt each is best designed for its own purpose.

The main object of the shaft of any furnace is to recuperate the heat of the gases from the melting zone, and to give to CO an opportunity to reduce part of the ore. In the ordinary blast furnace the weight of the gases is approximately 3½ times that of the gases in the electric furnaces, so that for the latter, the shaft could be proportionally smaller. However, this weight of gas is increased by the gas circulation, and Mr. Leffler reports very emphatically that the shafts of the furnace at Trollhätten were found to be very satisfactory. Again, the temperature of the gases entering the shaft of the electric furnace is lower than with the blast furnace, so that there is less heat energy to be absorbed in the former shaft, and it should be correspondingly smaller.

It is, however, to be kept in mind that the total heat contained in the gases of the blast furnace at about 1100°C. exceeds the heat which can be absorbed by the charge, whereas the heat contained in the gases of the electric furnace is very much less than that required by the charge. Mr. Frick points out[3] that 'by varying the amount of circulating gas in the electric furnace the total heat brought into the shaft by gases can be made to equal, to exceed, or to become less than the heat which will be absorbed by the charge.'

Of course the heat for the reduction in the shaft must come from some source, and its origin would be in the crucible; but the excess of heat there developed can be transformed by the circulation of the gas to the charge in the shaft as in the Trollhätten furnace, and not carried away by radiation and an excessive amount of cooling water as in the Noble furnace.

Depth of Electrodes within Melt.—In the report of the Trollhätten furnace it is said that 'free burning' electrodes are an essential feature, meaning that the electrodes were submerged in the charge as little as possible. This tends to cause arcing and an excessive amount of heat near the roof of the furnace. In the Noble furnace the electrodes were submerged as much as possible. No doubt this difference has much to do with the necessity of gas circulation to cool the roof of the Trollhätten furnace, as against the fact that this was not found to be necessary at Heroult.

Temperature of Crucible and Charge.—It seems to be established that in the Noble furnace with its rectangular crucible, the average temperature of the charge is considerably higher than in the Electro-Metals type of furnace, with its circulating gas. There are two very important consequences of this increased temperature.

[1] Metallurgical and Chemical Engineering, Vol. 9, page 632, 1911.
[2] Metallurgical and Chemical Engineering, Vol. 9, page 71, 1911.
[3] Metallurgical and Chemical Engineering, Vol. 9, page 632, 1911.

(1) *Sulphur Content of Pig.*—As a result of the latest Trollhätten runs, it is reported that a 'higher sulphur content is obtained than in an ordinary blast furnace.' This seems to the writer to be a peculiarity of the Trollhätten type of furnace which is deliberately arranged to reduce the average temperature to be lower than that of the blast furnace. It is well established that the desulphurizing reactions require a high temperature, and analysis of the pig from the California electric furnace shows that it is 'practically free from sulphur.'

Analysis of California Pig Iron[1]:—

Si	3·64 per cent.
S	0·00 "
P	0·02 "
Combined C	0·00 "
Total C	3·58 "
Mn	0·00 "

These analyses should be carried to another place of figures to be significant, but the statement accompanies them that the metal is practically free from sulphur.

The ore from which this pig was made contained about 0·01 per cent sulphur.

(2) *Production of Grey Pig Iron.*—The demand in California is for a soft grey foundry iron. The Noble furnace yields that product, partly due to its higher temperature, which is favourable to the reduction of silica to silicon, and partly due to the fact that the reduction is performed solely by solid carbon in the crucible, which again reduces silica to silicon. Silicon dissolves in the iron, and causes carbon to precipitate out in the graphitic form. In consequence there is produced the soft grey iron desired.

In the Swedish practice, by reducing the amount of fuel, and by running at a low temperature, a product was obtained with 0·1 per cent Si, 0·1 per cent Mn, and as low as 1·5 per cent carbon. This in reality is not pig iron at all, but *pig steel.* This is the material which is now being manufactured by the Swedish operators, and which their particular type of furnace is best calculated to produce.

Swedish Electrothermic Pig Steel—At first there was considerable misgiving as to the value of this white pig steel, but after some experimenting it has been found to have very decided advantages over ordinary pig iron for the manufacture of steel. Quoting Dr. J. W. Richards[2]—'As to the advantages of this material for steel making, the fact that it contains 97 to 98 per cent iron instead of the 92 to 94 per cent in pig iron, means that there are only 2 or 3 per cent or less of impurities (instead of 6 or 8) to be removed in the steel furnace. The steel workers found at once the advantages of pig steel. Put into the open-hearth furnace it is converted into steel with half or less of the ordinary refining. The output of open-hearth furnaces using pig steel is increased nearly 50 per cent.'

'Thus the result has been beneficial all round. The pig iron furnace makes more of this pig steel in a day than it does of pig iron, and at less cost; the steel furnace makes more steel per day from this material and at less cost. This rather accidental discovery has completely absorbed the attention of the Swedes and Norwegians. They say that not only have they a new process for making pig iron cheaper than in the blast furnace, but they can make a product which they never could make in the blast furnace, which is dollars a ton cheaper when converted into steel.'

Production of Steel at Degerfors from Electrothermic Pig.—The first attempt at using the metal produced at Trollhätten for the production of steel, was made at

[1] Metallurgical and Chemical Engineering, Vol. 10, page 457, 1912.
[2] Metallurgical and Chemical Engineering, Vol. 10, page 398, 1912.

Degerfors[1] in a basic furnace. Results exceeded expectations, and after a time charges were made up of only electric furnace metal and scrap, none of the ordinary grey iron being mixed in as at first. The conclusion from the work at the steel plant at Degerfors, is that a metal was being produced in the electric reduction furnace at Trollhätten, which was more suitable for steel making than the ordinary pig iron which had previously been used for this purpose.'

Pig Iron—Pig Steel; Heroult—Trollhätten.—It must not be inferred that it is not possible to produce normal pig iron in the Electro-Metals type of furnace, for as a matter of fact very considerable quantities were so produced in Sweden. However, the Trollhätten furnace makes pig steel more efficiently than it makes pig iron. The Trollhätten furnace is operated to produce pig steel because this metal is better suited to steel making than is normal pig iron, whereas the Noble Electric Steel Company of California operate their furnace so as to produce a soft foundry iron, which is particularly suited to meet the requirements of that section of the country.

Burned vs. *Unburned Limestone.*—There can be no doubt that theoretically the method of charging calcined limestone is proper, but Mr. Leffler reports that, due to increasing the percentage of fines in the charge, it makes the charge hang in the stack, and consequently can not be used with the Electro-Metals furnace.

Graphite Electrodes.—There are obvious advantages of the graphite electrodes used in California over those of carbon used at Trollhätten, although the breakage at Heroult has thus far been excessive.

Circulating Gas and Water Vapour.—Mr. Frick points out[2] that from 10 to 15 per cent of the carbon consumption in the Trollhätten furnace is used in the reduction of the water introduced by the circulating gas. Mr. Leffler in his reply to Mr. Frick,[3] although answering most of Mr. Frick's criticisms, makes no mention of this point. This, of course, is saved in the furnace without gas circulation.

Power Consumption.—No complete figures are at hand giving power consumption, etc., for the Noble furnace, as are given for the Trollhätten furnace, but it has been stated by the manager of the plant[4] that the power consumption at Heroult has averaged 1,940 KW. hours per ton, which is equivalent to 3·36 tons per H.P. year. This figure was not reached in the Trollhätten furnace during its first five months of operation, but during the second smelting campaign there were produced, for a considerable part of the time, 3·92 tons per H.P. year.

Recent Commercial Developments—That the production of pig steel has met the requirements of the Swedish and Norwegian steel makers is demonstrated by the fact that, in consequence of the successful operation of the furnace at Trollhätten, and of the satisfactory steel tests at Degerfors, the following plants have been built and are now in operation.[5]

Place.	No. of furnaces.	Rated H.P. capacity.
Domnarfvet, Sweden	1	3000
Hardanger, Norway	1	3000
Hagfors, Sweden	2	3000
The following are approaching completion:		
Hardanger, Norway	1	3000
Arendal, Norway	3	3000
Switzerland	1	2500

[1] Metallurgical and Chemical Engineering, Vol. 10, page 539, 1912.
[2] Metallurgical and Chemical Engineering, Vol. 9, page 634, 1911.
[3] Metallurgical and Chemical Engineering, Vol. 10, page 71, 1912.
[4] Metallurgical and Chemical Engineering, Vol. 9, page 635, 1911.
[5] Metallurgical and Chemical Engineering, Vol. 10, page 539, 1912.

The Uddleholms Company are also increasing their plant at Hagfors by a third furnace, and are installing three more furnaces at their Nykroppa works. Altogether they propose to spend about $1,700,000 on these plants, and it is stated that they will probably completely substitute electric smelting for their blast furnaces.

Another large electric pig iron plant is projected at Cogne, Italy.[1] Six million tons of iron ore, 60 per cent Fe, very free from S and P, are available, near water power amounting to 37,000 H.P. Electric pig iron furnaces are to be erected, and the electric pig charged directly into electric steel furnaces. 'It is believed that with an abundance of power the Company will be able to utilize electric furnaces on a large scale, operating independently of combustible fuels, and in this way establish an entirely national Italian industry.'

The Electric Furnace as a Means of Producing an Improved Quality of Steel.—In 1904, there were four electric refining furnaces producing steel in Europe and America, whereas in June, 1912, there were over seventy.[2] A number of these furnaces are competing successfully with crucibles in the manufacture of very high grade steel.

As compared with the Bessemer and basic open-hearth processes, the electric has the following advantages:—

(1) The more complete removal of oxygen.
(2) The absence of oxides caused by the additions, such as silicon, manganese, etc.
(3) The production of electric steel ingots of eight tons in weight and smaller, that are practically free from segregation.
(4) Reduction of sulphur to 0·005 per cent, if desired.
(5) Reduction of phosphorus to 0·005 per cent, as in the basic open-hearth process but with the complete removal of oxygen.
(6) Production of steel of any carbon content.

Electric steel ingots crack much less in rolling, are denser, and show a greater elongation for the same tensile strength than either Bessemer or basic open-hearth. With the electric furnace it is possible to produce steel which when magnified 1,000 diameters, shows no oxides or slag enclosures.

In 1912, there were approximately 5,600 tons of standard electric steel rails in service in the United States. These rails have been on the track for about two years, exposed to wide ranges of temperature and to all possible conditions of severe service. 'Up to the present time we have not heard of any basic electric rails in use in this country being broken in service.'[3]

Thus there is no question as to the superior quality of electric steel, due to the almost ideal conditions of control of the melt. The cost need not be prohibitive, but to be a minimum the capacity of the refining furnace should be equal to that of the converter, and they should be placed near together.

It is certain that there will be a decided increase in the production of electric steel for heavy products in the near future. It is not unlikely that electric steel furnaces will be installed with electric smelting furnaces at some of the important water-powers. This combination offers great possibilities of economy and of product.

General Conclusion.—We may say then that the electric iron reduction furnace has passed the experimental stage, and that it is meeting the requirements of the localities where it has been introduced. It is beginning to find extended application in Sweden, Italy, and California, and will, no doubt, be introduced on a large scale wherever power is sufficiently cheap and where coke and charcoal are comparatively costly.

---

[1] Metallurgical and Chemical Engineering, Vol. 10, page 744, 1912.
[2] Metallurgical and Chemical Engineering, Vol. 10, page 371, 1912.
[3] Wm. R. Walker, U.S. Steel Corporation.
Metallurgical and Chemical Engineering, Vol. 10, page 372, 1912.

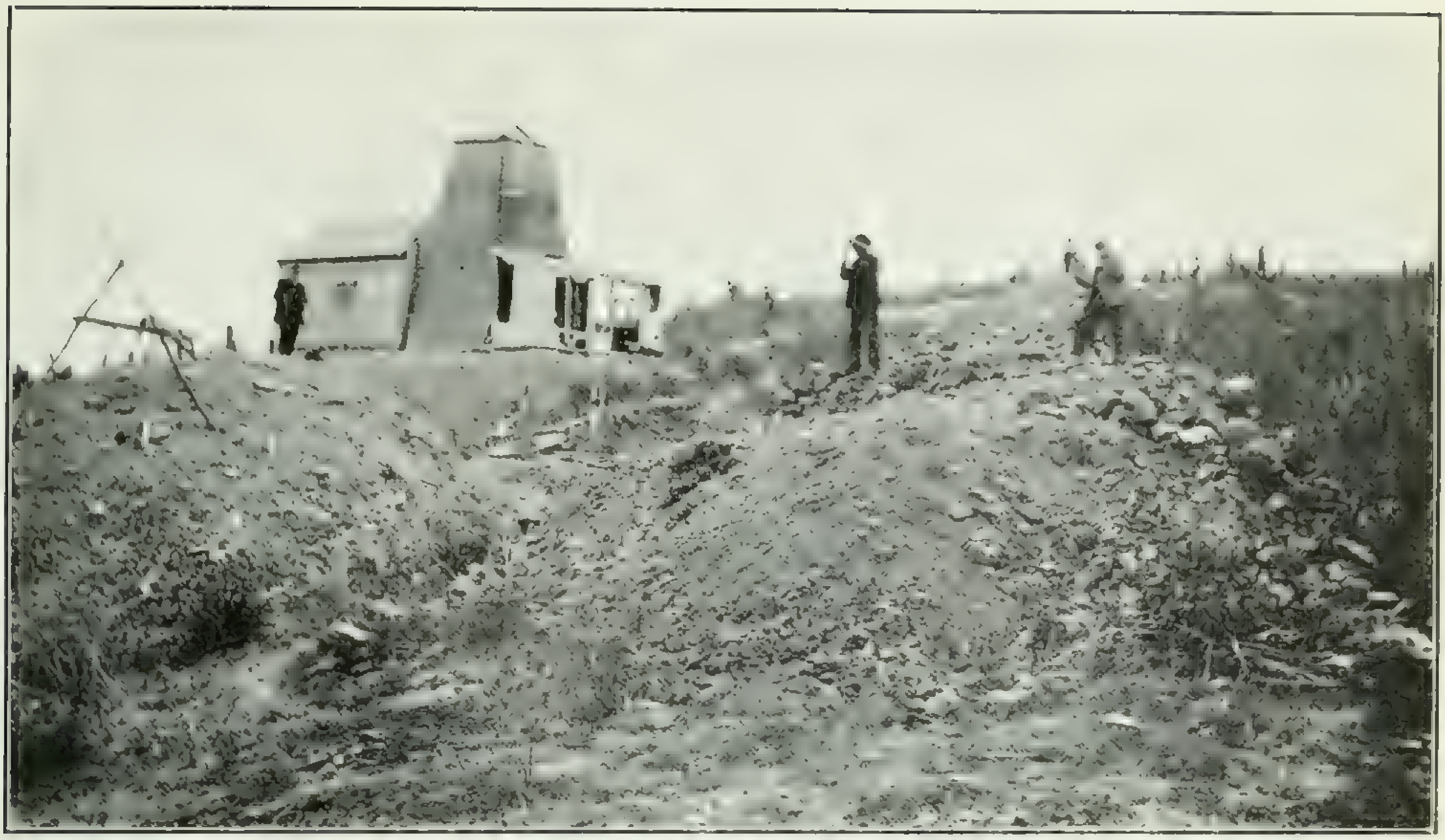
It is not solely a matter of the substitution of electric power charges for about two-thirds of the fuel cost, of comparative installation charges, etc., but the fact that a superior quality of iron for the manufacture of many kinds of steel is produced, is an all important consideration.

Electric refining furnaces are producing the very highest grades of steel, and are rapidly increasing in number throughout Europe and America. The erection of electric refining furnaces in conjunction with electric smelters offers great possibilities.

PLATE VIII.

Front street in Mayo, Stewart river, Y. T.

26a 1913 p. 122.



Sampling ore at the Violet, Eldorado, Y.T.

Sampling ore at the Violet, Eldorado, Y.T., July 6, 1912.

On the trail to Dublin gulch.

LODE MINING IN YUKON: AN INVESTIGATION OF QUARTZ DEPOSITS IN THE KLONDIKE DIVISION.

T. A. MacLean.

INTRODUCTORY.

Lode mining in Yukon has for some years past been attracting considerable attention.

As early as 1899 quartz claims were staked over considerable areas throughout Klondike district, but development work has generally been carried on in a desultory fashion, and little real mining done. Staking continued, however, until, at the present time, quartz claims are located over wide areas throughout the mining districts of Dawson and Duncan Creek in northern Yukon, Conrad and Whitehorse in the south, besides extensive areas in the White river and other outlying portions of the Territory. The latter, however, do not come within the purview of this report.

HISTORY.

A comparatively detailed history of gold production in Yukon may be found in various reports of the Geological Survey Branch issued during the last twenty odd years.[1]

Briefly, the output of placer gold, though subject to annual fluctuations, has been gradually on the decline; as a result largely of improved equipment, however, the year 1912 has resulted in the largest yield for several years.

The banner year was 1900, when Yukon supported a population of over 30,000 people, with a gold production of $22,275,000. The population in 1912 is estimated at 8,500 people, and the placer gold production probably exceeded $5,500,000. In addition to this $9,500 was produced by gold lode mining.

With the decrease in production of placer gold, the hope for the Territory lies in the development of lode mining, and earnest efforts are now being made to devise means for fostering this industry.

Mr. McConnell, writing in 1905, says[2]:—

"Lode mining has so far made little progress in the Klondike district, although a great number of claims have been staked, and some development work has been done on a few of them."

The local government gave, from time to time, some assistance, notably in the form of roads and trails to the properties. Indeed the extent of road making has been quite remarkable, indicating that the authorities realized the absolute necessity of good roads in any attempt to develop this extensive territory.

The Dominion Government also gave aid in the form of a sampling mill,[3] and assay office, and sent a couple of diamond drills into the district, but in 1905 the mill was abandoned or dismantled, the assay office closed, and the drills allowed to remain idle until the latter part of this season when one of them was being set up at the Pueblo mine near Whitehorse.

In 1909, Dr. D. D. Cairnes reported in part as follows[4]: "Considerable interest has of late been displayed concerning the quartz of the Klondike, and special

[1] Dawson, Dr. G. M., Geol. Sur., Can., Annual Rep., Vol. III, Part I, 1887-88, pp. 178-183 B.
McConnell, R. G., Rep. on Klondike Gold Fields, Ann. Rep. Geol. Sur., 1905, part B, Vol. XIV.
Brock, R. W., Sum. Rep. Geol. Sur., 1909, pp. 16-23.
Cairnes, D. D., Quartz Mining in Klondike, Geo. Sur., 1911, and others.
[2] McConnell, Rep. on Klondike Gold Fields, Part B, Ann. Rep., Vol. XIV, page 64.
[3] Appendix to the Rep. of the Supt. of Mines, Part VI, Ann. Rep., 1902.
[4] Cairnes, D. D., Sum. Rep. Geol. Sur., Dept. of Mines, 1911, Quartz mining in Klondike district, by D. D. Cairnes, Introduction, page 33.

efforts are being made to develop the lode mining of this district in the hope that a revenue may eventually be derived from this source, that will continue to foster the mining industry of this portion of Yukon, when the placer deposits have become exhausted, which it is thought, however, will not be for many years to come."

The situation at the beginning of 1912 was such that on January 2, the Yukon Miners' Association, by resolution appealed to the Dominion Government for assistance in the development of their lode mining, and specifically for the placing in operation of the government diamond drills then in the territory and for the establishment in Dawson of a testing mill and laboratory for treatment of ore.

Dr. Cairnes, who had then recently made a cursory examination of a few of the quartz properties, wrote under date of February 14, 1912, as follows[1]:—

"For a number of years past, and particularly since 1905, when the government mill and assay office in Dawson were closed, relatively very few assays of the quartz of the Klondike have been made, and as new deposits are being discovered each year, but little is known concerning the probable value of the bulk of the quartz now known to occur in the district."

The government's response to the appeal of the Yukon Miners' Association was an appropriation for the purpose of carrying on the work epitomized in this summary report.

PROCEDURE.

The chief difficulties in the way of an effective prosecution of the contemplated investigation of Yukon quartz deposits were confronted on arriving at Dawson, on June 6, 1912, immediately after opening of navigation. The main obstacles were as follows:—

(1) The great extent of the field as compared with the limited available time and means.
(2) The differentiating of known deposits.
(3) The mapping of an itinerary that would embrace the more promising properties with minimum loss of time due to unnecessarily retracing ground.

Through the courtesy of Dr. Alfred Thompson, M.P., and the Hon. George Black, Commissioner for Yukon, quarters were secured in the Government Administration Building at Dawson, and the public advised, through the columns of the local press, that all persons interested in lode mining properties might there get in touch with the mining engineer sent in by the Dominion Government.

A prompt response was the result, and, within a week, many persons interested had furnished data on which it was possible to plan an itinerary, subject to such modification as might later be deemed necessary.

As a number of the properties in the more immediate vicinity of Dawson are located up the creeks at varying distances, and in different directions, that city became something of a hub and a work-room was there established.

Arrangements were also made with Mr. Wm. C. Sime, Assayer of Dawson, now Territorial Government Assayer with headquarters at Whitehorse, for the prompt assaying of samples. This was considered imperative in order to afford data for immediate advice to prospectors on their own ground; the latter being informed that advice as to comparative values or methods of work would be given free. Duplicates of all samples were at the same time forwarded to the Department at Ottawa, and results of both the local and departmental assays will be found tabulated in the complete report.

[1] Letter to Dr. Haanel, file No. 460.

ITINERARY.

A brief account is here given, showing the order in which different properties were examined, together with general outline of routes adopted. Details as to distances, etc., appear in the report in connexion with each individual property and need only be touched upon here.

The first property examined and sampled was the Lone Star mine on Victoria gulch. Little hesitation was experienced in making this selection on account of its comparative accessibility, and the fact that it is the only producing lode mine in the Dawson mining district. This property was one of several mentioned by both Mr. McConnell and Dr. Cairnes as among the more promising deposits, others being the Mitchell, Violet, and Lloyd groups, Bear creek, and Dublin gulch, the latter in the Duncan Creek mining district.

The Lone Star was reached via the Klondike railway from Dawson to Grand Forks, at the junction of Eldorado and Bonanza creeks, and thence via Bonanza creek and Victoria gulch to the mine. The party, consisting of three, arrived on Friday, June 14, and remained until Saturday, June 22, on which date a brief visit was also made to the Eldorado Dome, an adjoining property.

Bear creek on the Klondike was next visited, June 25 to the 29th. This embraced three different properties. On the latter date mentioned a preliminary visit was also made to properties of Mr. John Fawcett, on the right fork of Hunker creek.

On July 3, the party, accompanied by Mr. David Cullen, visited properties on Eldorado, to wit: Golden gulch and the Violet, remaining until July 12; proceeded to MacKinnon creek, and spent ten days in examination of properties of Messrs. MacKinnon Brothers and associates there, and on properties of Mr. Chris. Fothergill and associates, on Indian river and Conglomerate creek.

On July 30 the party proceeded by team from Dawson up Hunker to the King Dome, and Gold-run properties and there examined the following:—

Lloyd group.
Green Gulch group.
W. D. MacKay's property, head of Gold-run.
Patterson group.
Box Car group.
The Mitchell group.
Portland group on Portland gulch.
W. D. MacKay's group, Hunker.
John Fawcett's claims, Hunker, Right Fork.

Besides claims of Joseph Fournier, James Cameron, and others, including the Dome Lode property.

On August 16, in company with Dr. Wells, a visit was made to properties of The Wells' Quartz Mining Company on Lapine creek, a tributary of Rock creek. This was reached by driving over the mountain back of Dawson, a distance of 12 miles, by a very rough and steep road.

On August 21, the party left Dawson via S.S. *Vidette*, for Mayo, 240 miles distant on the Stewart river, en route for Dublin gulch, arriving at Mayo Saturday, August 24; proceeded next day by team wagon and pack horses, reaching Dublin gulch, about 50 miles inland from Mayo, over a very heavy trail on Wednesday, August 28. Properties here visited, extending over a distance of about 8 miles, were as follows:—

Stewart and Catto group.
Independence group.

Potato Hill group.
Shamrock group.
Olive group.
Blue Lead group.
Eagle group.

On September 5, after about eight days on this ground, left for Mayo, thence on the 10th for Dawson; taking small boat from Mayo, rowed down the Stewart and Yukon, calling at mining property of Pickering and associates on the right limit of Yukon, 18 miles above Dawson, and reached the latter city Friday evening September 13.

Property of J. A. Anderson on Excelsior creek was next visited by Mr. D. MacLachlan, first assistant of the party, and on September 21, the second visit was made to the Lone Star and Eldorado Dome properties.

On September 23, properties on Hunker, including California Girl, and Unexpected mineral claim, were visited with Mr. Pickering, and on September 24, a second visit to Bear creek included an inspection of property of Mr. W. O. Smith, on the left limit of Klondike about half a mile below the mouth of Bear creek.

On September 28, embarked for Whitehorse and Carcross, where it was arranged that some properties in the Wheaton, Watson, and Windy Arm should be visited.[1]

At this stage, the appropriation for the work being almost exhausted, it was impossible to do more than look over the ground, and secure a few trial samples in the shortest possible time.

A brief visit was made to the Pueblo Copper mine of the Atlas Mining Company near Whitehorse, also to the Valerie, Grafter, and Best Chance, controlled by the same company.[2]

The Anaconda Copper property, a few miles from Whitehorse, was next visited and sampled.

October 5 drove to Wheaton via Robinson en route to Buffalo Hump group, of Geo. Stevens; Tally Ho group, and Becker and Cochrane's mine.

Arriving Carcross October 17, proceeded by motor boat through Lakes Nares, Tagish, and Marsh, to Fiftymile river in the vicinity of which are situated Golconda and Florence Mineral claims.

Following this a visit by motor boat was made to Windy Arm and samples taken from

The Micmac group of P. Kennedy,
Humper group of Dail and Fleming,
The Venus mine, one of Col. Conrad's properties;

this trip being completed October 28.

After leaving this field a stop-over at the Alaska Treadwell mine on Douglas island was arranged for purposes of observation and comparison.

To the initiated it will readily be seen by a glance over the above itinerary, that anything like an exhaustive examination of this field was absolutely out of the question, as many of the individual properties visited would alone require weeks of thorough sampling to accurately determine their value.

The choice, however, lay between a complete sampling of several deposits, with possibly negative results, to the exclusion of all others, and a somewhat preliminary examination of the greater portion of the field, with sufficient sampling to indicate the promising portions, in the hope that means might later be found for their thorough

[1] Cairnes, D. D. Report on a Portion of Conrad and Whitehorse mining districts, Yukon, 1908.
See also Memoir No. 31, Wheaton district, by D. D. Cairnes, Geol. Surv., Can., 1912.

[2] McConnell, R. G., Whitehorse Copper Belt, Yukon Territory, Geol. Survey, Canada, 1909.
See also Sum. Rep. Geol. Survey, Can., 1909, p. 15.

investigation. The latter plan was adopted as being the only practicable method, and the one best calculated to afford the greatest amount of information for the given expenditure of time and money.

EQUIPMENT.

This consisted of an ordinary sampling outfit as follows:—

1 Simplex hand ore crusher, weight 175 lbs.
1 large mortar and pestle.
1 set of screens, 8-40 mesh.
1 set (3) cold chisels.
1 hammer and 2 prospecting picks.
1 smooth rubber mixing cloth.
1 spatula and camel hair brush.
1 chamois skin and bottle of quicksilver.
1 leather ore sampling sack, and about 500 necessary duck sampling sacks.
1 prospector's gold pan.
1 Chatillon spring balance, graduated from 2 ozs. to 60 lbs.
1 field balance, weighing to 10 mg.
1 pocket compass and clinometer.
1 surveyor's compass.
1 50 ft. steel tape.
1 field glass (stereo binoculars, 8 power), pocket magnifying glasses.
1 3-A kodak with tripod.
1 aneroid barometer.
1 blow pipe set with sundries.

Blankets and sundry small cooking utensils were also included, together with such supplies as were required from time to time when moving through the more isolated portions of the field.

METHOD OF SAMPLING.

Owing to the great variety as regards character, extent, and development of the deposits visited, it became necessary to adapt the method of sampling to local conditions.

As a general rule the crusher and sampling outfit were taken to the field or to a central location in the vicinity of a number of adjacent properties, and samples collected assembled, and worked up.

Samples varied in weight from a few pounds up to 1,250 pounds. The greater number, however, being in the vicinity of 6 to 10 pounds.

In case of a deposit definitely exposed, samples were taken clear across the lode, if not over 4 feet wide; for greater widths two or more samples would generally constitute a section.

The intervals at which samples were taken varied, but wherever convenient, 10 or 12 up to 50 ft. intervals along the strike would be adopted. As much sampling was done over outcroppings and other irregular exposures, it will be seen that any fixed rule as to intervals could not be rigidly followed.

Many of the workings of prospects were inaccessible owing to water and ice or other obstructions, in which event samples were taken from excavated vein matter. Indeed the latter was freely sampled to furnish trial or indicator samples.

All samples were carefully guarded, being immediately sacked and removed to the work room, dried if necessary, broken and crushed through eight mesh or at times forty mesh screens, then mixed by rolling on a smooth rubber sheet, coned and quartered down until two half-pound duplicates were secured (the fines from discards

being carefully brushed off the sheet). The final samples were then numbered by a folded paper tag inside the sack, sealed with private seal from the Mines Department, and locked in leather sack until such time as one set could be delivered to the assayer in Dawson and the duplicates forwarded to Ottawa.

The discards were then panned and examined for minerals, and where necessary, and as time permitted, tested by means of the blow pipe.

In the case of the largest samples, these were broken with hammers first to about small egg size, mixed and quartered, the quarters being rebroken smaller, and again quartered down to seventy or seventy-five pounds, then crushed and reduced in the usual manner.

Samples taken at Dublin gulch were generally smaller than others, and the final duplicates were quarter instead of half-pound weight. This was considered advisable in view of the necessity of packing them 25 or 30 miles over rough and wet trails.

EXTENT OF THE FIELD.

Reference has been made to the great extent of the field: more explicitly the Klondike gold field which embraces that portion of Yukon lying between and within the valleys of the Yukon river on the west, the Klondike on the north, Indian river on the south, extends to Flat and Dominion creeks on the east, and includes about 800 square miles.

While most of the detail work of this examination was carried on within the above area, prospects at Dublin gulch, as already mentioned, distant some 290 miles by land and water from Dawson, came in for some attention, as did also certain sections of Whitehorse, Wheaton, Watson, and Windy Arm, the latter four all lying within an area of about 1,000 square miles.

GENERAL GEOLOGY.[1]

This subject will here be taken up very briefly, being more fully treated in complete report.

Briefly, the geology of this region is complicated, and rock formations are found ranging in age through the greater part of the geological scale and exhibiting varied structure and composition.

In many instances it is practically impossible to absolutely classify certain of the rock formations on account of gradual alteration of massive igneous rocks into schists and of clastic rocks into the appearance of igneous rocks.

With reference to the origin of Yukon gold, the opinion has been expressed by such authorities as Brock,[2] McConnell,[3] Cairnes, MacLaren,[4] and others, that the bulk of the alluvial gold found so abundantly had its origin locally in quartz and schists, which had been eroded and washed down the creeks.

That the greater part of the Klondike gold is detrital in character and local in origin is the most reasonable explanation of its occurrence. This was abundantly substantiated in the case of Victoria Gulch gold. During the present examination this

---

[1] 1900. R. G. McConnell, Klondike Gold Fields.
1905. R. G. McConnell, Klondike Gold Fields.
1906. J. Keele, Upper Stewart River, and C. Camsell, Peel river and tributaries, Yukon and Mackenzie.
1908, D. D. Cairnes, Conrad and Whitehorse mining districts, Yukon.
1909, R. G. McConnell, Whitehorse Copper Belt, Yukon.
1910, D. D. Cairnes, Lewes and Nordenskiöld Rivers coal district, Yukon.
1912, D. D. Cairnes, Wheaton district, Yukon Territory, Memoir No. 31.

[2] Summary Rep. Geol. Survey, Can., 1909, p. 19.

[3] McConnell, R. G., Ann. Rep. Geol. Survey, 1905, Part B, Vol. XIV, p. 61 B.

[4] MacLaren, Dr. J. M., "Gold, Its Geological Occurrence and Geographical Distribution," pp. 482-3.

gold was found both in the quartz and schists of the Lone Star Ridge and also in the rim-rock exposed on placer claims now being operated in the Gulch below, as well as in the gravels where it was found angular and but slightly worn.[1]

It is very probable that many billions of tons both of quartz and schists have been ground down and their gold content concentrated in the creek beds. This opens up an avenue for discussion as to whether the gold was originally distributed throughout the matrix in such quantities as to be economically valuable. The fact of large grains and nuggety gold occurring in the creeks would seem to have warranted the hope of the prospector that rich lode deposits might yet be lying in wait for the miner's pick and drill.

Quartz Veins.—Quartz veins, which occur widely distributed throughout the old schistose rocks of the Klondike, are prevailingly of the lenticular variety, and are found sometimes interbedded with the schists and again cutting the latter both in strike and dip. Bunches and stringers of quartz and sheet-like veins also occur, the latter generally interleaved with the folia of the schists. In size the veins vary from fractions of an inch in width and a few inches in length up to several feet wide. They are at times several hundred feet long; usually, however, the individual lenses are considerably less.

Typical or extensive fissure veins are rare, and, on account of the decidedly schistose and fractured character of the enclosing rocks, readily pass into the types above referred to, as being prevalent throughout the district.

Dr. Cairnes concludes this to be due to the frequent diversion, in whole or in part, of the quartz-bearing-solutions from the particular channels along which they might at any time be travelling.

Exception must be made to above general conditions in case of quartz deposits, both at Dublin gulch and at the southern end of Yukon district, where fissure veins occur in comparatively regular form, carrying widths of several inches up to a few feet, for hundreds of feet along the strike. At Dublin gulch the fissured belt extends many thousand feet in the same direction, containing a number of veins which have every indication of continuity at depth.

Methods of Prospecting.—Reference has been made to lack of systematic prospecting. In this connexion, a mistaken idea has been abroad among lode miners or prospectors in the district, to the effect that surface trenching and sampling are a useless waste of time. Many prospectors consider that, when an outcrop of quartz occurs, a shaft must first be sunk on it, or if the outcrop occurs on a summit, that a tunnel should be started from the foot of the hill to tap the lead at depth. Either of these methods of prospecting may consume much time and money before any information, as to probable extent or value of the deposit, is secured.

The proposition for the prospector or miner is simple and may be enunciated somewhat as follows: learn most about your property with the least possible expenditure.

One foot of sinking or tunnelling costs as much as 25 to 50 feet of surface trenching, in shallow work. While the information acquired is doubtless worth more per foot of depth than per foot of surface, both must ultimately be obtained, *and for the lone prospector* the knowledge of his surface outlines and values is, as a rule, readily obtainable. If these are promising money can, generally, be found to assist him in developing at depth.

It is not the intention of this report to question the value of sinking or of drifting in its proper place, nor to pass severe strictures upon the method or lack of method, employed by many owners of quartz claims. It is the intention rather to emphasize advice given in the field, to wit: that when an ore body is discovered, it is good policy

[1] Compare McConnell, R. G., Ann. Rep. Geol. Survey, 1905, Part B, Vol. XIV, pp. 39 B—40B.

to stay with the ore, avoiding long and expensive cross-cut tunnels, driven for the purpose of tapping the lead at depth, since it may not be there, and again to sample systematically and thoroughly all workings during their progress.

Neglect of the above simple principle has cost this district dear, and the lack of exact information with regard to numbers of deposits on which thousands of dollars have been spent is truly lamentable.

MINES AND PROSPECTS.[1]

GENERAL.

Of the forty odd properties visited, the majority exhibited no more development than actual assessment work required. A number evidenced large expenditures with but meagre results in the shape either of knowledge acquired or available, and lamentable ignorance of the first principles both of mining and economy.

A few were, during the season of 1912, undergoing legitimate development, notably the Lone Star mine, at Victoria gulch, two or three properties at Dublin gulch, a couple in Wheaton, including the Whirlwind group of Becker and Cochrane; the Humper group of Dail and Fleming, on Windy Arm, besides several copper properties in the Whitehorse copper belt, and other lesser properties.

All the individual properties visited will be dealt with in the final report, so that only those which are considered immediately deserving of mention are here referred to. It should be noted, however, that no attempt is made in this summary report to detail any of the work done on the Whitehorse, Wheaton, or Windy Arm properties, for the reason that results of all samples taken are not yet at hand, and it is impossible to so classify the data in connexion with them as to give a comprehensive summary. Suffice it that these properties are not here omitted in consequence of not measuring up to some others incorporated in this report, but this portion of the territory has been recently reported upon by Dr. Cairnes,[2] and Mr. McConnell,[3] and it is realized that the only really important addition to these reports would be detailed results of sampling.

It may here be stated, however, that, from a number of assay results, already at hand, several of these properties indicate values ranging variously from traces to upwards of \$58 in gold and silver; and though mining in a portion of this territory has received a set-back as a result of suspension of work in the Big Thing and Venus mines, by Col. Conrad, who was probably the largest lode mining operator in southern Yukon, there are still a few prospectors whose confidence in their properties may, it is thought, be warranted.

LONE STAR MINE.

Probably of first importance in Dawson district, among lode mining properties, is the 'Lone Star mine,' on the eastern slope of Victoria gulch.

This property consists of four crown-granted and seven ungranted claims, with the addition of three creek claims.

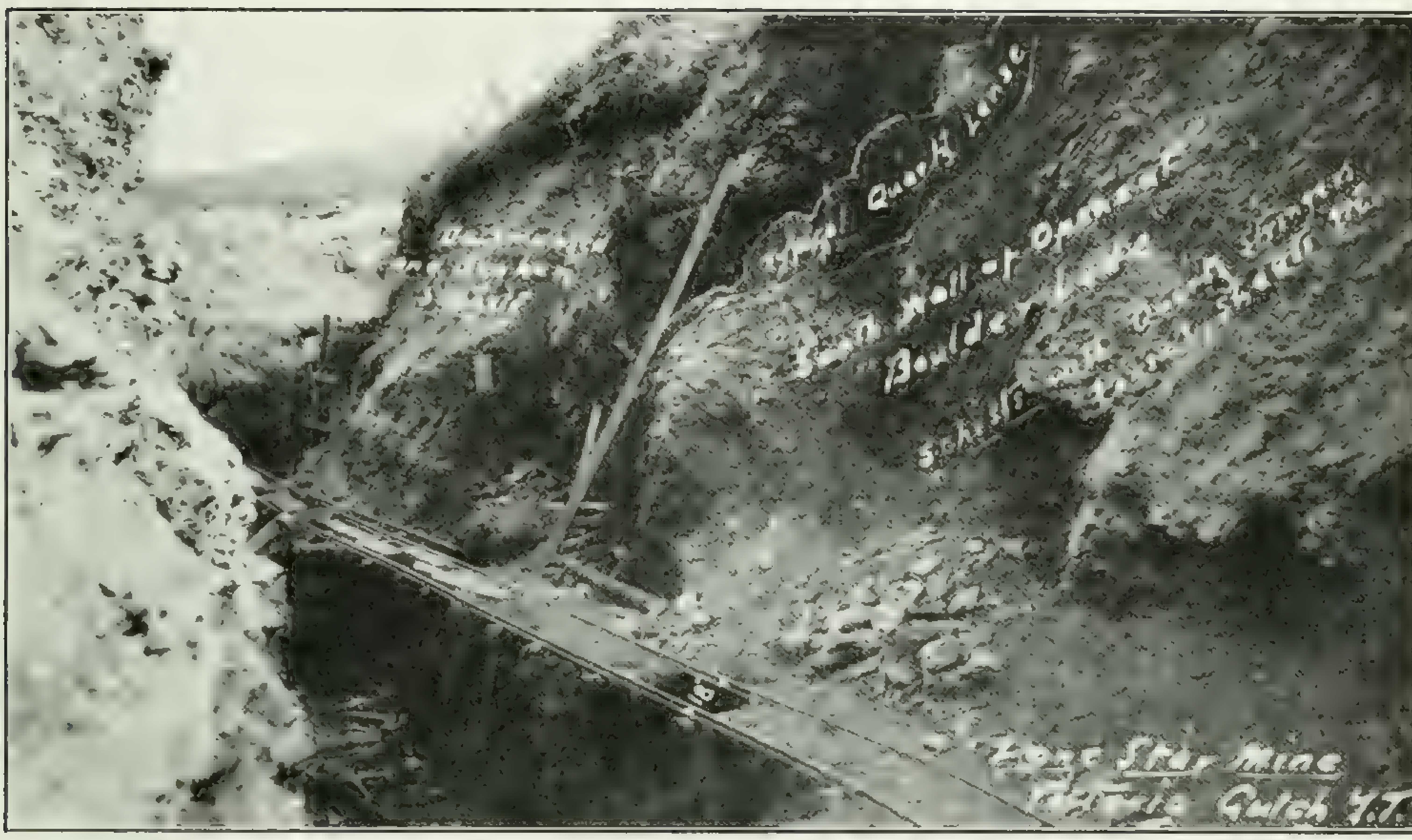
It is distant 6 miles from the town of Grand Forks, the nearest railway station, and about 20 miles by road from Dawson.

---

[1] Appendix to the Report of the Superintendent of Mines, Part VI, Ann. Rep., 1902.
McConnell, R. G., Ann. Rep. Geol. Survey, 1905, Part B, Vol. XIV, pp. 64-66 B.
Cairnes, D. D., Summary Rep., Geol. Survey, 1911, pp. 36 and 37.

[2] Cairnes, D. D. Report on Portion of Conrad and Whitehorse mining district, Yukon. Geol. Survey, Can., 1908.
See also Cairnes, Memoir No. 31, Wheaton district, Yukon Territory, pp. 106-113.

[3] McConnell, R. G., Whitehorse Copper Belt, Yukon Territory, Geol. Survey, Can., 1909.



Open cut, Boulder lode, Lone Star mine.

A stage coach leaves the latter city daily for Grand Forks and there is a government road straight to the mine; the latter having been built in 1909 at a cost of some $7,000. It is a comparatively good though steep road, rising some 1,500 feet in the last 2 miles.

The history of this mine dates back to 1899, but it was not until 1909 that the Lone Star Company, Ltd., was organized. Between that date and 1912 about $42,000 in round figures have been spent in purchase, equipment, and development.

The chief officers are:—

Dr. William Catto, President, Dawson.
J. Henry, Secretary-Treasurer, Dawson.
E. H. Searle, Manager, Lone Star mine.

Equipment.—This consists of mess and bunk house, frame building, 20 × 35 feet, 1½ story.

Blacksmith shop, 16 × 20.

Lowering gear for 3,500 ft. gravity tram to handle 3,000 lbs. net in car.

1 Joshua Hendy 4 stamp mill, with crusher.

50 H.P. general electric motor attached to power transmission line, connecting with power plant of the Northern Light and Power Co.

Nature of Deposit.—The outstanding feature of the deposit is that it consists chiefly of a mineralized zone or mass formation called by the owners 'The Boulder lode.'

So far as shown by present development, the so-called Boulder lode is made up of a large number of quartz lenses or kidneys, sheet-like veins, bunches, and stringers of quartz ramifying through a mass of micaceous or sericitic schists, which are much crushed, folded, and metamorphosed.

The individual quartz lenses are very irregular and possess but little continuity. They occur in a zone or belt, having in most places, a west northwesterly strike, and constitute from 20 to 25 per cent of the whole rock mass.

This lode has heretofore been confined to a narrow belt which, at the time visited in June, was being worked by an open-cut about 10 to 15 feet wide, 12 to 18 feet deep, and having a general strike N. 85° W.,[1] *i.e.*, heading somewhat into the contours of the hill and thus gradually increasing the height of the working face.

For reasons discussed in the complete report, it is concluded that the deposit may be much wider. As a matter of fact, on this being suggested, the management increased the width of face in the cut with satisfactory results referred to below.

The quartz is generally white to grey, with rusty stain on seams or fracture faces due to oxidation of sulphide minerals, which are found sparsely distributed in the quartz and schists.

Gold occurs generally free and very fine, but coarser masses, scales, and small nuggets, are found both in the quartz and on contact faces, while small wheat-like grains are found in the crushed schists. Small values also occur associated with the sulphides.

Method of Working the Property.—It has been the practice to sort the ore and about one car in three went to the mill, two going to the waste dump. This practice was maintained until August when the management, acting on suggestions as to the possibility of milling the mine-run, and extending the width of the workings, closed the mill from August 8 to 12, inclusive, for the purpose of making necessary changes and adjustments to increase the mill capacity. They restarted on August 13, from which date until October 1, when the mine closed for the winter, Mr. Searle states, not a single car was sent to the waste dump.

[1] All bearings given in this report are magnetic, the variation being from 31½° -35° E. according to location. Vide various maps of Yukon.

At the same time the working face had been widened, and instead of being 10 or 15 feet was found to be 35 feet wide across the top in September, when visited during part of a day.

The net result, as stated by the manager, was that the mill output was multiplied by three. Average values recovered only fell about 20 cents per ton, and a loss in operating of approximately one dollar per ton was converted into a gain or profit of like amount.

Sampling.—The deposit is an unusual one and presented peculiar difficulties in view of the comparatively short time available for the work. It was not known *definitely* whether the quartz contained all the values or whether these were distributed through the quartz and schists; and while a system of sorting was in vogue under the direction of the foreman, it was quite empirical.

With a view, therefore, to define these points, samples were taken of quartz lenses alone, of schists alone, and of both together, as well as average sectional samples.

Forty-nine samples were taken from the whole property, but very few have shown even fair values, many giving traces only. The highest assay[1] from an original sample (*i.e.*, apart from concentrates) was $21.44, and this was not taken from the open-cut which is the source of the mill supply. A complete assay chart and analyses of the samples will be given in the final report; suffice it for the present that assays were so uniformly low that an average value of the deposit worked out from them, on any basis possible, would show it between 50 cents and $1 per ton.

Mill returns,[2] on the other hand, show an average value per ton which varies but slightly by the month from $3.694—$3.90 over a period of more than four months and for a tonnage of 2,495 tons milled.

Taken alone the assay results would practically condemn the property, but from observation it can be definitely stated that rich bunches of quartz frequently occur.

Variation between the sampling of a property and the mill run is, in case of free milling quartz, a very usual occurrence, though the rule is the reverse of the above experience, and the mill-run generally underruns the estimates based on sampling and assay returns.

This matter will be further discussed in the final report.

Following is an abstract showing results of the mill-run. This is supplied and certified substantially correct by the manager, Mr. E. H. Scarle.[3]

Gold extracted from open-cut on Lone Star, Ltd., mine during summer of 1912, as per bank of British North America certificates:—

May, June, and July.	$ 3,880 42	from 994 tons,	Average $3.904 per ton.
August	2,146 22	" 581 "	" 3.694 " "
September	3,440 94	" 820 "	" 3.74 " "
	$ 9,467 58	2,495	3.76

Operating Costs.—According to the management, September operations resulted in a net profit over all charges of about one dollar per ton, thus demonstrating that, even with the handicaps consequent upon working a small plant with insufficient funds for necessary improvements, ore can here be mined and milled at a cost of $2.75 per ton. This cost would be materially reduced if the number of stamps could be increased and improvements, which the manager has in view, provided for.

[1] The assay returns noted in this Summary Report are based on results obtained by Mr. Wm. C. Sime, assayer, of Dawson. The value adopted per oz. of gold is $20. In the final report, returns of assays made by the Division of Chemistry of the Mines Branch, will also be included.

[2] See statement of mill return by the manager, as found below.

[3] This information is further vouched for by the annual statement of the Company.

Maier's placer workings on Victoria gulch. Lone Star mill in the background.

The present mill is well equipped. As mentioned above it is a four stamp Joshua Hendy, with stamps arranged in two batteries having automatic feed and triple discharge, and two 4 feet × 7″ well dressed plates for amalgamating.

Tailings are carried over about 15 feet of sluice box with wooden riffles and two sets of blankets, where concentrates are retained.

The concentrates assay $12 and upwards per ton, but the percentage of concentration has not been checked up.

A 50 H.P. general electric motor furnishes power from the transmission line attached to power line of the Northern Light & Power Co., and with this equipment the power cost (at 4 cents KW.) in June was about $1 per ton of ore crushed. With the increased output[1] of the mill in August and September, this would be almost cut in half.

The present mill is conveniently situated on the left slope of Victoria gulch as shown by accompanying photograph, and the site offers every facility for extension.

Detail Costs.

Manager's salary[2] at present	$150 per month and board.			
Foreman's "	"	150	"	"
Millman's pay	"	5 per day and board.		
Miner's "	"	4	"	"
Cook's "	"	4	"	"

Number of men in the mill by day 2, by night 1.
Number of men on tramline and incline 2.
Number of men in and about the mine, 4.[3]

Following are prices of a few of the more staple articles for provisions. To these prices must be added the freight at 1 cent per pound.

Flour, $8 per cwt.; Tea, 50 cts. per lb.; Butter, 40 cts. per lb.; Sugar, $12 per cwt.; Eggs, (case) 75 cts. per doz.; Eggs, (fresh) $1.50 per doz.; Canned fruit, $4 and $4.75, case of 2 doz.; Salt, 10 cts. per lb.; Potatoes, 6 to 10 cts. per lb.; Beef, 40 cts. per lb.; Bacon, 40 cts. per lb.; Kr. oil, 75 cts. per gal.; Gasoline, 80 cts. per gal.

Summary.—The Lone Star property has been referred to at considerable length, and the above details furnished for the reason that, throughout the whole Klondike, they have a vital bearing on the situation as it relates generally to lode mining.

As already stated this is the only producing gold lode mine in the Klondike. Speculation is rife as to the possibilities of its developing into a great mine.

Data has heretofore been lacking as to the probable cost of mining and milling in the district.

As a result of examination herein described, the conclusion reached with regard to this property is: that a more thorough sampling should be undertaken, or, better still, extensive mill tests made of material not only from the present workings, but from other sources on the property, in order to demonstrate whether the values occur over the extensive area outlined in this report.

As already noted, so far as developments have shown, this may be a mountain of auriferous quartz and schists carrying values; with the possibility of occasional very rich zones, due to leaching or other processes of secondary or surface enrichment. Additional colour is given the hypothesis of an extensive deposit by the fact that the

[1] In June, the mill tonnage was about 12 tons in 24 hours, while in September it was raised to about 30 tons in 24 hours.

[2] Owing to the manager's personal interest in the property, this is nominal amount.

[3] The above number was noted at time the mine was visited and probably represents an average for the season.

adjoining property to the south and west, to wit: the Eldorado Dome, exhibits many of the same characteristics as those of the Lone Star deposit. Though comparatively little development work was done on the latter, some rich quartz and schists were seen in a prospect trench on the Robin Mineral claim, several (possibly five) thousand feet southwest of the Lone Star workings, details of which will be given later in connexion with description of Eldorado Dome property.

The Lone Star Company is handicapped for money with which to prospect its property. Absolutely dependent as it is on the recovery of the mill to meet current expenses, the Company cannot undertake systematic development. Yet this must be done before any great expectations can be realized.

There is little question but that such a property as this, if located in the Porcupine district of northern Ontario, would be amply supported, and financed for extensive prospecting.

It is not the purpose or intention of a governmental report to boost a proposition of this kind. The situation with regard to this particular property is herein fairly set forth, and all the data available at time of writing will be given in the full report.

In a few words then, the Lone Star deposit is probably extensive. The above sampling has disclosed poor values, but the mill returns would indicate the possibility of a future for the property.

One good lode mine in Klondike district would put new heart into the business, and afford sufficient encouragement to induce active prospectors and miners to take the field, when a new area in connexion with the lode mining industry might thus be inaugurated.

OTHER MINING PROPERTIES.[1]

Other properties in Dawson mining district deserving of further consideration, including mill tests, are the Violet group on Eldorado,[2] the Eldorado Dome properties adjoining the Lone Star, and the Virgin mineral claim on Bear creek, all of which partake to some extent, of the characteristics noted in connexion with the Lone Star deposit. In this list might also be included the Mitchell,[2] and the Mackay properties at the head of Gold-run, and possibly the Lloyd and Green Gulch groups.

The Mitchell exhibits considerable development, which includes a shaft, supposed to be 80 feet deep, together with surface trenching. The latter uncovers a strong vein striking northwest which carries a width of 18 inches up to 6 feet. This vein is uncovered for about 350 feet, and cross-trenching and outcrops at intervals indicate the probability of its persisting for upwards of 2,000 feet, and cutting the schist folia in strike and dip.

Twenty-one samples were taken at intervals on this vein, though only three showed assay values above traces as follows: $2.43, $10.47, $22.72. Eight others showed colours of gold in the pan indicating that some values at any rate may be better distributed than the assay results showed.

Mackay property near head of Gold-run and on the right limit of Portland gulch, exhibits a strong looking ledge of quartz, from which two samples assayed $34.90 and $3.42 respectively. Free gold was seen in the ledge, but, though promising, this prospect requires opening up, as a first move towards further investigation.

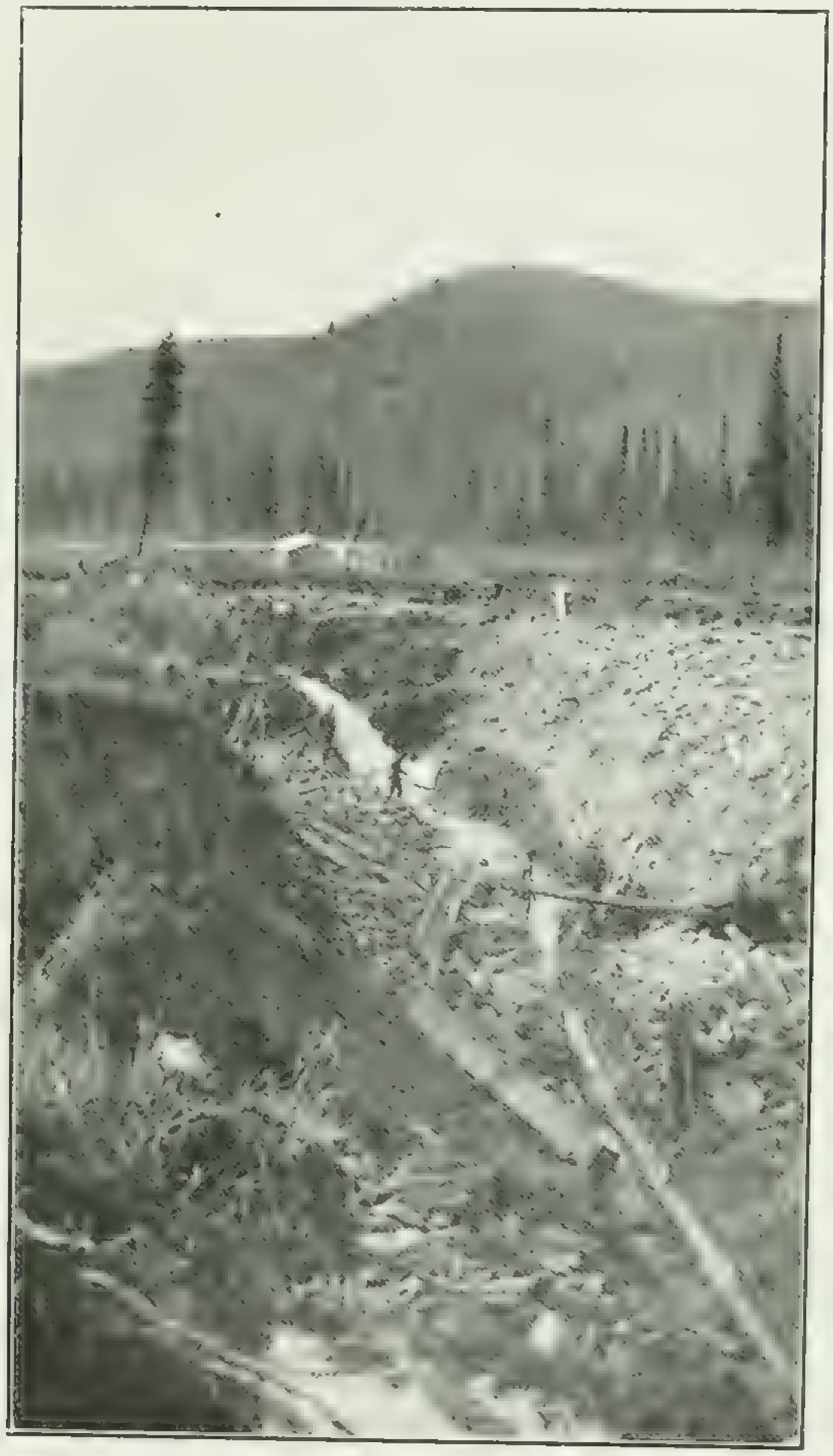
Duncan Creek Mining District.[3]

DUBLIN GULCH.[4]

As mentioned in the itinerary previously outlined, the claims staked in this vicinity extend generally in a northeast and southwest direction over a length of 8

[1] McConnell, R. G. Part B, Ann. Rep. Vol. XIV, Geol. Sur., Can., 1905, pp. 64B-66B
[2] Cairnes, D. D., Sum. Rep., Geol. Sur., 1911, pp. 37-38.
[3] Keele, J., Ann. Rep. Geol. Sur., Can., Vol. XVI, 1904, pp. 38A-39A.
[4] Cairnes, D. D., Sum. Rep. Geol. Sur., Can., 1911, p. 40.

PLATE XIV.



Jack Suttle's placer workings on Dublin gulch.

or 9 miles. The most important are located along the limits and at the head of Dublin gulch, which enters the left limit of Haggart creek, a tributary of McQuesten river.

When visited in September these claims were unsurveyed.

General Geology.

Locally the formation consists of quartzites, quartz mica schists, and chlorite schists, probably referable to McConnell's Nasina series.

The quartzites and quartz schists are so closely associated as to grade into one another. Fine banded quartzites and schists prevail with interbandings of quartz whose average thickness is about one-sixteenth of an inch. These are intruded by heavy masses of grey biotite granite, and at times by dykes of decomposed and altered granite and by other dark igneous rocks. Iron stains are prevalent throughout, varying in colour from ochreous to dark brown and black.

Dynamic forces have here resulted in tremendous movements of the earth's crust. These have resulted in great fracturing, and deep gulches occur below the summits which bear evidence of erosion.

Some Quartz Deposits.

At Dublin gulch, quartz veins occur widely throughout a fissured belt of these schists, which lies along a generally well defined granite contact, striking northerly and southerly along the ridge above the left limit of Dublin gulch, and towards the head of the gulch, running into the Potato hills. These hills are rounded and steep and are aptly named. They have an elevation of 5,400 feet, *i.e.*, some 2,000 feet above the mouth of Dublin gulch.

These veins have generally a northeasterly and southwesterly strike heading towards the granite contact, and though not there explored, possibly run into contact veins. One drift on the Olive claim is said by Mr. J. E. Moskeland, who did the work, to have exposed this condition, though when visited this drift was inaccessible.

These veins vary greatly in width from a few inches up to 6 feet and even more. Occasionally cross veins were noted, that is striking northwesterly and southeasterly, but these appear to be rather an exception. One, however, of some importance was examined on the Shamrock group of Mr. Frank Carscallen.

Gold is found in these veins over the whole length prospected. A typical feature of the auriferous quartz is its association with a green mineral compound probably scorodite[1] (a hydrous arsenate of ferric iron), which occurs in the nature of a pay streak from 4 or 5 up to 20 inches wide, striking with or in the veins. The greenish stain is recognized as distinctive by the prospectors, and just as the purple fluorite of Cripple Creek, Colorado, afforded a guide to pay ore, so this has been of great assistance. Unlike the former, however, where values occur in irregular *ore shoots* within the fissures, of greater vertical than lateral extension,[2] here the *pay streak* follows the fissures in the manner above noted.

These veins are usually and sometimes heavily mineralized with arsenical pyrites. Occasional particles of pyrite are found; the quartz in places is coated with a yellow ferric arsenate. Most of the gold, however, is free, though very fine and apparently well disseminated, as evidenced by the fact that nearly all the samples panned gave fine colours of gold in the form of minute dust. Some wire gold was noted. Frequently small values in silver were found on assay.

---

[1] This classification of associated mineral is only tentative. For the full report this will have been more thoroughly investigated.

[2] MacLaren, Dr. J. M., "Gold: Its Geological occurrence and Geographical distribution," p. 552.

Associated also with the more regular fissure veins are stringers, bunches, and more rarely lenses of quartz. Masses also occur which may be regarded as impregnated zones of country, besides igneous dykes which probably have a genetic relation to the auriferous depositions, but which require time and study for proper definition and correlation.

One of the greatest drawbacks in this section is lack of detailed geological maps or of any surveys of the properties. As the ground is steep and comparatively rugged, it was impossible in the time available to properly correlate the various prospects.

Some of the individual veins were, however, traced for several hundred feet, and, as above noted, it is evident veins occur for several miles which may have a continuous, or approximately parallel, strike. In confirmation of this it may be here remarked that several pups[1], tributary to Dublin gulch, cross-cut the formation, and expose a system of approximately parallel veins which have a perpendicular attitude, and cut the schists both in strike and dip. The schists where noted have a prevailing dip to the southwest.

INDIVIDUAL PROSPECTS.

Stewart and Catto Group.—Of the Dublin Gulch properties visited, that of Stewart and Catto exhibited most extensive development. This property comprises five mineral claims located on the divide between Stewart and Olive pups, which enter the left limit of Dublin gulch, the former pup about 1½ miles from the mouth of the gulch.

Work has been confined to the Happy Jack and Victoria mineral claims and consists of a couple of tunnels with drifts, together with some considerable surface trenching.

Several veins have been partially exposed. One known as the Green vein, on the left limit of Olive pup, by cross trenching for over 150 feet, strikes N. 58° W. and was found to carry a width of from 2 to 8 feet.

About 125 feet of tunnelling was done in the vicinity by Mr. Jack Stewart, but not on the vein. This work disclosed stringers of quartz associated with impregnated zones of country. Five sectional samples were taken at intervals along the tunnel, and these gave an average assay value of $3.61 per ton. Two trial samples from walls of tunnel gave $4.65 and trace respectively. A trial sample from the dump at tunnel mouth gave $11.10, while five sectional samples from the surface trenches on the Green vein averaged only 90 cents, over a length of 150 feet and width of 3 feet.

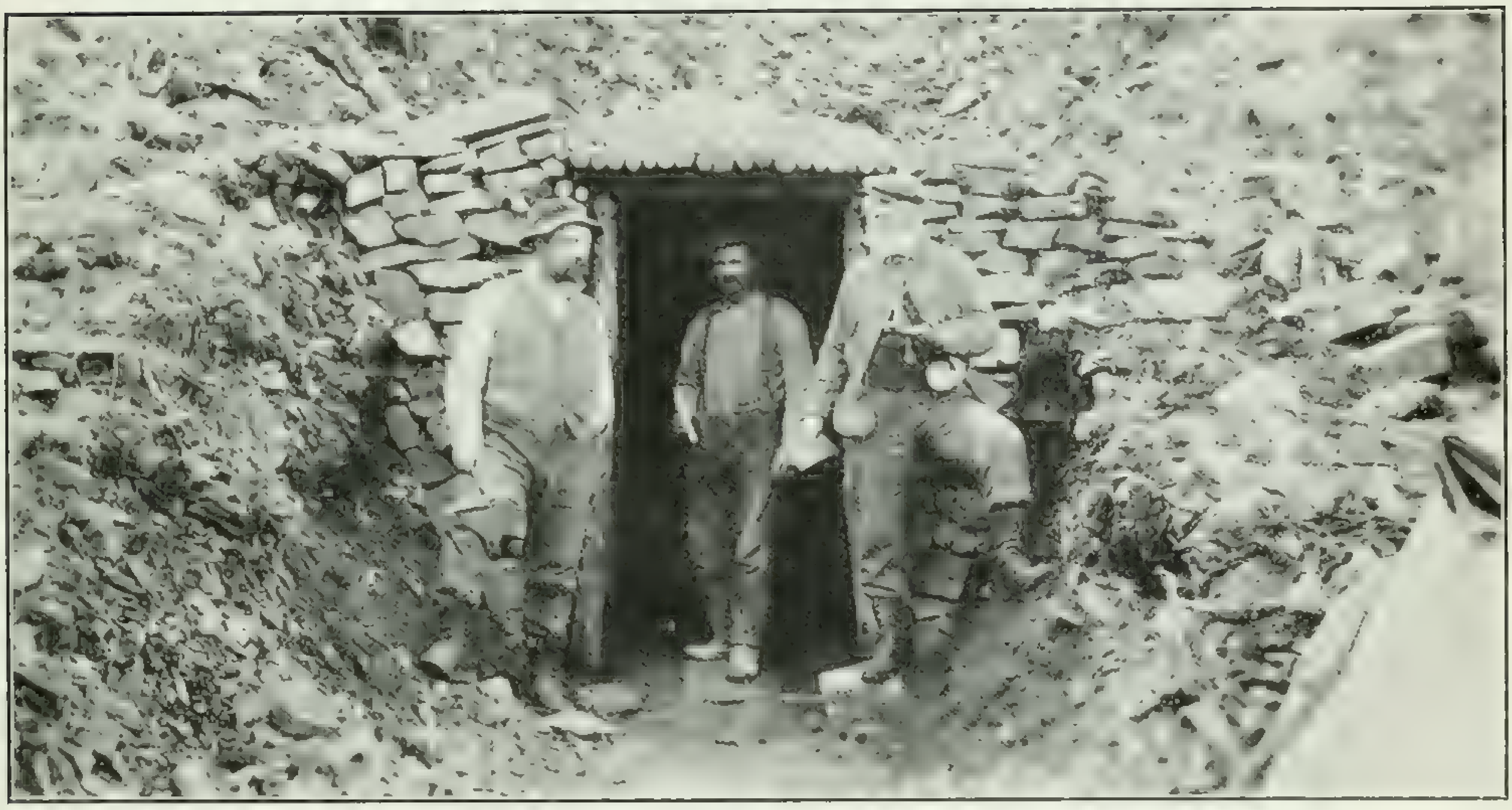
Another cross-cut tunnel is driven S. 75° E. 200 feet into the side hill on the left limit of Dublin gulch, and to the south of the Olive pup. At 125 feet in, this tunnel cross-cuts a fissure vein which strikes approximately N. 50° E., has a perpendicular attitude, and cuts the schists both in strike and dip. This was drifted upon for 27 feet right and 47 feet left, or 74 feet in all, and carries an average width of 4 feet, which bulges to 7 feet in the face of left-hand drift.

This vein consists generally of a central pay streak from 5 to 20 inches wide, of greenish quartz and probably scorodite, with decomposed and oxidized portions of rusty quartzose material, together with a vein filling of quartz and country from which some colours may be panned. This occurrence has been named the Victoria or Moose-tunnel vein.

The arithmetic mean of 10 samples,[2] taken at approximately equi-distant intervals, is $4.35, but allowing for variable widths (the so-called foot-ounce method) the average is $3.48 per ton.

[1] The word "pup," where used in this report, signifies a small tributary of a gulch. The term has been adopted in reports issued by the Federal Government from time to time, and may be found on the various maps of Yukon Territory.

[2] One sample No. 278, included in the above, was taken from surface trench on this vein above the tunnel and should not perhaps have been included in the tunnel samples. This will be differentiated in the full report when assay sheets are completed.



Tunnel of Stewart and Catto on left limit of Olive Pup.

Simultaneously with the above, two samples, one in the face of each drift, taken by Dr. Catto, and assayed by Mr. Athelstane Day (assayer for the bank of British North America), gave $14.44 over a width of 20 inches and $4.43 over a width of 7 feet, or an average of $6.36.

Three trial samples, taken from the dumps near entrance of tunnel, gave the following results:—

No. 288	assayed	$16.92	The first two being material from pay streak and the third from vein filling.
No. 289	"	13.23	
No. 290	"	4.53	

Assuming that the first two gave an average of the streak, i.e. $15.08, and that this material represents about one-fourth of the whole as against three-fourths of the vein filling at $4.53: we then have as an average of the whole excavated vein matter, $7.17.[1]

The above figures may be taken to indicate that values somewhere between $3.48 and $7.17 are established as a probable average.

A third vein, called the *Cabin vein,* has been uncovered at a distance of 400 to 500 feet northeast from Stewart's cabin, on the side hill right limit of Stewart pup.

The strike is approximately N. 10° to 15° E. Several trenches cross-cut this vein at intervals of 50 feet. Width varies from 2 to 8 feet, and the occurrence is typical of the district. Average of five samples taken at intervals over a length of 100 feet is between $3 and $4.

Still another prospect is shown by a trench 150 feet in a direction S. 35° W. from the entrance of Moose tunnel. Here a vein is exposed 3 feet wide, striking as near as might be judged N. 10° to 15° E. and dipping 68° westerly. A sample across the vein gave $6.94.

Summary.—From the foregoing results it is considered that this Stewart and Catto property well warrants more extensive development.

As a first requirement for its systematic investigation, a complete transit survey is necessary, so that the various scattered workings may be properly correlated.

Olive Group.—Adjoining the Stewart and Catto property is the Olive on the opposite limit of Olive pup. The only work that has been done here is on the Olive mineral claim itself, which is registered in Mrs. Agnes Jane 'Kenzie's name, and represented on the ground by her brother, Mr. Robert Fisher.

Work consists of several surface trenches, a short cross-cut tunnel and drift, the work being done by J. E. Moskeland, under a 'lay' agreement.

One trench, 100 feet long, situated some 500 feet N. 72° E. from Moskeland's cabin on the right limit of Olive pup, exhibits an irregular occurrence of altered and decomposed granite and talc, associated with quartz schists and broken stringers of quartz in contact with granite. A couple of samples, here taken, show values of 40 cents each. The occurrence is somewhat indeterminate.

About 800 feet from the mouth of Olive pup, on its right limit, is 'Bob' Fisher's cabin, and 750 feet N. 50° E. from this, and at an elevation 330 feet higher, a tunnel was started into the hill about N. 20° E. for a distance of 8 feet. Here a split was made to follow a dyke of altered and decomposed granite containing quartz stringers, the drift being N. 72° E. Portions of this were allowed to cave so badly that when visited it was impossible to penetrate beyond 30 feet. Mr. Moskeland, however, stated that at 60 feet along this drift he cross-cut a good vein of quartz, striking with the main granite contact, and that the green pay streak was 20″ wide. He drifted on this

---

[1] This is based on the supposition that in this 4 ft. vein, 1 foot might be taken as a fair average of the width of the pay streak.

for a number of feet, and the existence of the pay streak was evidenced by green quartz vein matter on the dump; a couple of trial samples from which (Nos. 316 and 317) gave values of $35.71 and $51.65 respectively. Two samples taken 15 feet apart in the drift gave $9.57 and $1.09 respectively. Two samples taken from the left hand split gave trace and 0·83 cents respectively.

Another trench, some 300 feet north from the tunnel, and at a higher altitude, which was intended to cross-cut the continuation of Stewart's green vein, showed only stringers of quartz in decomposed and altered dyke matter associated with quartz schists. Two trial samples here gave $4.42 and $1.18 respectively. This property evidently warrants further prospecting.

Shamrock Group.—This comprises 4 mineral claims controlled by Mr. Frank Carscallen. It is situated at the head of Dublin gulch, and to the west and north of the Olive mineral claim. Two veins have been prospected merely in a preliminary manner.

One strikes about N. 15° E. being exposed by a couple of outcrops and an open-cut. The former are on the ridge above the right limit of the main fork of Dublin gulch—at an approximate elevation of 4,500 feet—the open-cut is on the side hill, a couple of hundred feet lower down on the slope towards the gulch.

Even in the latter cut, which is 7 feet wide, the vein is not clearly exposed, but has the appearance of a filled fissure between quartzite and granite, the contact on the west being quartzite. The eastern contact is not uncovered, but a heavy mass or bluff of grey biotite granite occurs some 15 feet to the east of the cut. Between the two is considerable overburden.

The width of vein exposed is 5 feet, and comprises 1 foot of rusty quartz and 4 feet of a pale greenish variety of quartz and scorodite, typical of those described as prevailing throughout the district. A sectional sample here assayed $3.68. Two samples on outcroppings referred to gave trace and $3.30 respectively. Indications are that the vein extends for several hundred feet.

The other vein prospected was tapped by a tunnel situated 250 feet down stream from the above described open-cut, and several surface trenches were also made, cross-cutting the line of strike, which was approximately N. 75° W.

When visited the above-mentioned tunnel was inaccessible. Mr. Carscallen stated that the lead was here 2½ feet wide, having 1 foot of white quartz carrying iron sulphides as found on the dump, and 1½ feet of green stained quartz; the walls being porphyry.

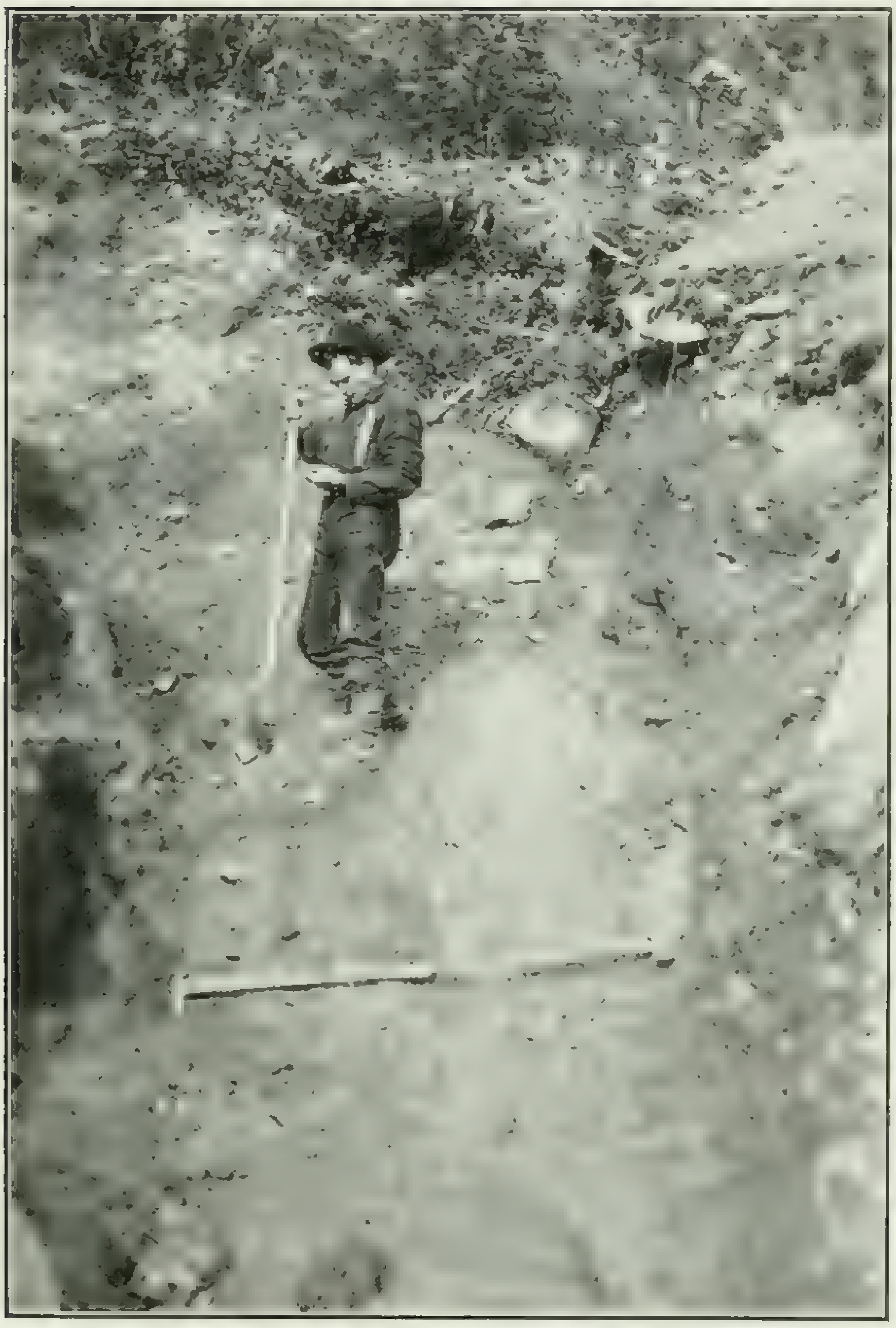
A trial sample of typical vein matter taken from the dump assayed $9.67, while material which had come from the walls assayed 44 cents.

Where seen in two surface cuts several hundred feet apart northwesterly on strike, the occurrence presented rather the appearance of a wide dyke of altered granite and quartzite, containing central green pay streak associated with rusty quartz, and the dyke matter is completely decomposed. The cuts show 7 to 15 feet, in width, of this material, and several samples being taken assayed values from traces to $10.06.

The depth here exposed is only 3 feet, and from results shown it can be recommended that further prospecting should be done. Best results would probably be obtained by driving directly on the lead through the present tunnel, which, it is understood, cuts the former diagonally. As the ground here is steep, head is rapidly gained and values at depth exposed.

Blue Lead Group.—Comprises 8 claims, located in vicinity of Stewart pup and between groups of Stewart and Catto on the north and the Eagle group on the south. This property is controlled by Mr. Bowles C. Sprague of Dawson.

Some prospect work was in progress during the season of 1912 on the Blue Lead mineral claim. A shaft was started near the summit which overlooks the left limit of Stewart pup, and was sunk 25 feet on a vein which strikes northeast with a perpendicular attitude, through a dyke of altered granite and decomposed quartzite. This vein comprises 2 feet of decomposed greenish quartzose material mineralized with



Open cut showing 5 feet of vein on Frank Carscallen's property, Shamrock group.

sulphides of antimony, arsenic, and iron, which give it a bluish cast for about 8 inches of its width. The balance of 4 feet exposed in width of the shaft, is altered and decomposed dyke material, together with stringers and bunches of rusty quartz. An average sample, taken in two sections, 6 feet across the bottom of shaft, assayed $2.60. Two trial samples from excavated green vein matter, taken from the dump near the shaft, gave values $6.14 and $6.54 respectively, or an average of $6.34.

Two hundred and fifty feet from this shaft in a northwest direction, an open-cut exposes a greenish decomposed quartzose vein in contact with decomposed granite on the west, and talcose material on the east. A sample (No. 326), taken over a width of 2 feet, assayed $20.72; while 75 feet southwest from this, a second cut characterized by somewhat similar conditions gave a sample which assayed $2.06.

As these trenches merely constitute surface scratching, the occurrence is indeterminate, but suggests the probability that further prospecting might uncover a well defined fissure vein. The above results warrant further work.

Eagle Group.—This consists of eight mineral claims, situated on Eagle pup, a tributary on the left limit of Dublin gulch, about three-fourths of a mile from the latter's mouth.

Mr. Bowles C. Sprague and others of Dawson hold this property and the owners are represented on the ground by 'Bob' Fisher; the latter accompanied Mr. MacLachlan, who examined the property and describes it as follows:—

'Eagle pup, whose general direction is N.W. and S.E., here cuts the formation in such manner that on the S.W. side of the pup a very steep, at times almost perpendicular, wall exhibits a belt of country, comprising quartz schists and quartzites and containing four fissure veins, the first of which is exposed about three-fourth mile from the mouth of the pup; *i.e.*, near its head. This vein called No. 1 is 12″ wide, strikes N.E. with perpendicular attitude. The country strikes N. and S. and dips S.W., so the vein cuts it both in strike and dip and is characteristic of the district.'

One sample taken from the brow of this lead assayed only a trace. Another taken from below gave $27.31 over a width of 12″.

'Two hundred feet westerly from No. 1, a second vein called No. 2, is exposed in vertical face for a height of 30 feet. The width of this vein will average 6″. At the bottom is a trench which is only two feet wide, but shows that the vein splits and encloses a horse of schist; the width of vein is, however, 14″ at this point. This lead has a very well defined and regular appearance. It strikes north 30° E. in the direction of the shaft on the Blue Lead mineral claim, which is distant about 2,500 feet, and from general indications may be the same lead. Work is, however, insufficient to determine this.' A sample taken across this vein (No. 329) assayed $16.78.

No. 3 Lead is exposed 200 feet westerly from No. 2, and strikes N.E. dipping slightly E. through the country. It consists of quartz about one foot in width. Several openings, at distances of 20 feet off the line of strike of the vein, exhibit stringers of quartz similar to that found in the vein and dipping towards the latter.' A sample on this vein (No. 330) assayed $14.29.

'No. 4 Lead is exposed about a hundred feet west of No. 3, striking about parallel with it, and having similar characteristics. Its width is about 8″ and it consists of dark rusty broken quartz.' A sample assayed $16.05. A couple of other samples from open-cuts which exhibited broken quartz stringers and decomposed country in the vicinity of the veins, gave values $2.18 and $4.63 respectively.

'These veins have every indication of true fissures extending for considerable distances, and approximately paralleling each other.' The assays show favourable results, and some systematic prospecting should be undertaken; as for example, by drifting on the veins.

Summary and Conclusions.

In comparing the values variously shown throughout the Dublin Gulch properties, with those of the Lone Star mine, for example, it must be stated that conditions are very different in the two localities. Whereas $3 to $4 ore might be a bonanza in case of the Lone Star, it is thought that nothing less than $8 per ton over a stoping width of say, 3 feet, could be of much economic importance, either under present conditions, or any which are likely to be realized in the immediate future of Dublin gulch.

Several factors may be mentioned in the above connexion, *e.g.*

(1) The difference in the nature of the deposits.
(2) The greater distance from source of supplies, and difficulty of access through lack of roads.
(3) Probability of greater expense in recovering the values.

Of these the first mentioned is ultimately the important factor, as the others may, to a great extent at any rate, be modified. The local government had started work on a trail from Minto Bridge to Haggart creek, a distance of 20 miles, and if this be carried to the mouth of Dublin gulch, an additional 15 miles, conditions for the prospectors will already have been somewhat improved.

Owing to the fact that here the free gold generally occurs, well disseminated as minute dust, these deposits admit of sampling to better advantage than those of the Dawson district where spotty values prevail. Hence, more extensive sampling might be undertaken on several of these properties with beneficial results.

Mill and laboratory tests would be of great assistance both in deciding the values and method of treatment. As, at Dublin gulch, the free gold is very fine and some of the values occur in refractory form with arsenical pyrites, extraction would probably involve cyanidation, but 'It must be recognized that, before commercial development is inaugurated, every mining tract embraced within the zone of the proposed plant should receive more thorough investigation.'

Again, to quote Mr. J. E. Hardman, Ma.E.,[1] 'Manifestly in case of a prospect no attempt at valuation would be of any worth, the engineer at best can only endeavour to ascertain what measure of probability the prospect has of eventually becoming a mine. His report should clearly state this limitation, and should present all the facts he is able to ascertain, but may contain the opinion which he personally deduces from these facts.'

Having regard to the above, it may here be suggested that Dublin gulch is considered a very promising district, and though the average values as given are generally below requirements, there is a strong possibility that further development, accompanied by more detailed work than was on this occasion possible, might result in establishing beyond reasonable doubt the existence of one or two good mines.

Copper at White River.

During the past season considerable interest was awakened throughout the Territory, by further rich finds of copper reported from the White River district.[2]

It is known that, towards the end of the season, some prospectors brought out a few tons of copper ore for sampling purposes, and shipped it to the smelter at Tacoma.

If report as to the extent of some of these finds is at all true, this district should immediately become of great economic importance.

---

[1] Hardman on Examination and Valuation of Mines, Trans. Can. Soc. C.E., Vol. XVII, 1903, Part II, pp. 514-15.

[2] McConnell, R. G., Sum. Rep. Geol. Survey, Can., 1905, pp. 19-26.
Brock, R. W., Sum. Rep., Geol. Survey, Can., 1909, pp. 23-26.

Recommendations.

As to specific recommendations, it may be stated that, during the past season, it was frequently suggested by prospectors and miners that much good would result if the services of a geologist or mining engineer were constantly available throughout the district.

There is no doubt but that the field is large and offers ample work for not only one or two men, but also for reconnaissance parties that would eventually precede the individual prospector and pave the way for a more rapid development of a country whose fringe has, after all, been but scratched.

At the present time it is doubtful whether the results herein disclosed warrant the government in undertaking the erection of a testing mill, though, as already stated, a number of properties are deserving of further investigation.

It is considered, however, that a mill test is the only reliable means of finally deciding the value of certain properties here recommended, which are located in the Dawson district, and it is possible that some arrangement might be made, whereby the mill of the Lone Star Company would become available for the purpose of testing samples from these properties, under the supervision of a government mining engineer.

In case of prospects at Dublin gulch, and of those in southern Yukon, the conditions are different, and it is thought the more important of these will advantageously admit of more detailed sampling and assaying, in connexion with any further investigation of their individual extent.

There is work also for the government diamond drills in testing the copper ore deposits.[1]

The Atlas Mining Company, operating in the vicinity of Whitehorse, is a well organized concern, doing legitimate mining and developing on the Pueblo and other properties.

Some 25,000 tons of copper ore were shipped from the Pueblo up to September 30, and it was estimated by the management that 5,000 additional tons would be shipped before the end of the year.

It is important to Yukon, and particularly to Whitehorse, that these operations continue, as they undoubtedly must if the ore bodies are of sufficient extent and value to warrant it. The problem confronting this Company is, therefore, to outline the ore bodies and prospect at depth, and the government diamond drill which was being equipped in September should be of great assistance.

In conclusion it may be noted that this is a crucial period in the history of lode mining in Yukon, and too much importance cannot attach to the necessity of affording prospectors additional facilities for sampling their properties, and for securing advice as to the mode of development best calculated to provide a knowledge of the probable economic importance of given deposits.

---

[1] McConnell, R. G., the Whitehorse Copper Belt, Yukon Territory, Geol. Survey, Canada, 1909.

DRAUGHTING DIVISION.

H. E. Baine.

The staff of this division is at present composed of a chief officer, two map compilers, and one mechanical draughtsman.

The work assigned to this division consists principally in the preparing of magnetometric survey and geological maps, the drawing of original plans in connexion with the various mechanical plants, and the construction and drawing of original maps and diagrams used to illustrate reports.

During the past year, owing to the increase of work in this division, the staff was increased by an additional draughtsman.

The following is a list of maps, diagrams, and miscellaneous drawings prepared during the calendar year 1912. The name of the officer for whom they were prepared will be found in the margin.

Magnetometric maps	12
Maps (geological and topographical)	46
Diagrams	65
Miscellaneous, photos, etc.	145

L. H. Cole.—Plan of Manitoba Gypsum Company's property.
Map of Grand River gypsum deposits, Ontario.
Map of gypsum deposits, Dominion of Canada.
Map of gypsum deposits, British Columbia.
Map of gypsum deposits in Ontario, in relation to railway lines.
25 drawings and charts for cuts and plates.

B. F. Haanel.—Plan of Körting peat producer, gas plant.
Detail plan of Körting peat gas producer.
Plan of Körting improved wet coke scrubber.
Plan of newly devised tar separator.
Plan of side elevation, Körting peat gas producer.
Plan of rear elevation, Körting peat gas producer.
Plan of sectional elevation, Körting peat gas producer.
20 test charts for cuts.

A. W. G. Wilson.—Map, power lines, southern British Columbia, West Kootenay Power and Light Co.
20 drawings for plates and cuts.

Prof. Coleman.—Geological Map, Sudbury nickel region, Ontario.
" " Victoria mine, Sudbury, Ontario.
" " Crean Hill mine, Sudbury, Ontario.
" " Creighton mine, Sudbury, Ontario.
" " No. 3 mine, Sudbury, Ontario.
" " showing contact of norite and Laurentian in the vicinity of Creighton mine, Sudbury, Ontario.
" " of Copper Cliff offset, Sudbury, Ontario.
" " showing vicinity of Stobie and No. 3 mines, Sudbury, Ontario.

E. Lindeman.—Magnetometric map, vertical intensity, Blairton iron mine, Belmont township, Peterborough county, Ontario.

Geological map, Blairton iron mine, Belmont township, Peterborough county, Ontario.

Magnetometric map, vertical intensity, Belmont iron mine, Belmont township, Peterborough county, Ontario.

Geological map, Belmont iron mine, Belmont township, Peterborough county, Ontario.

Magnetometric map, vertical intensity, St. Charles mine, Tudor township, Hastings county, Ontario.

Geological map, St. Charles mine, Tudor township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Baker iron mine, Tudor township, Hastings county, Ontario.

Geological map, Baker iron mine, Tudor township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Ridge iron ore deposits, Wollaston township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Coehill and Jenkins mines. Wollaston township, Hastings county, Ontario.

Geological map, Coehill and Jenkins mines, Wollaston township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Bessemer iron ore deposits. Mayo township, Hastings county, Ontario.

Geological map, Bessemer iron ore deposits, Mayo township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario.

Geological map, Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario.

Magnetometric map, vertical intensity, Carlow township, Hastings county, Ontario.

Geological map, Carlow township, Hastings county, Ontario.

Index map, magnetite occurrences along the Central Ontario railway.

5 plans for cuts and plates.

E. Stansfield.—33 drawings for Laboratory, Fuel Testing Station.

G. C. Mackenzie.—Map, showing the distribution of iron ore sands, of the iron ore deposits on the north shore of the river and gulf of St. Lawrence.

Magnetic iron sand deposits in relation to Natashkwan harbour and Great Natashkwan river.

Natashkwan magnetic iron sand deposits, Saguenay county, Quebec.

Plan of proposed concentrating and briquetting plant, Natashkwan harbour.

Plan of proposed dredge with magnetic separators.

Elevation and floor plans, ore dressing laboratory.

Curves illustrating ratio, crude sand to concentrate, and percentages of concentrate.

Plan of roasting plant, ore concentrating plant.

LIST OF REPORTS, BULLETINS, ETC., PUBLISHED DURING 1912.

S. Groves,

Editor Department of Mines.

81. French translation: Chrysotile-Asbestos, Its Occurrence, Exploitation, Milling, and Uses, by Fritz Cirkel, M.E. Published October 3, 1912.
83. An investigation of the Coals of Canada with reference to their economic qualities: as conducted at McGill University, Montreal, under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others—
    - Vol. I.—Coals: sampling, crushing, washing, mechanical purification, and coking trials. Published March 6, 1912.
    - Vol. II.—Coals: steam boiler, producer, and gas engine trials, also chemical laboratory work. Published May 5, 1912.
    - Vol. III.—Appendix I: Coal washing tests and diagrams, by J. B. Porter. Published October 21, 1912.
    - Vol. IV.—Appendix II: Boiler tests and diagrams, by R. J. Durley. Published February 20, 1913.
    - Vol. V.—Appendix III: Producer tests and diagrams, by R. J. Durley. Published May 15, 1913.
    - Vol. VI.—Appendix IV: Coking tests, by Edgar Stansfield, M.Sc., and J. B. Porter.
      Appendix V: Chemical tests, by Edgar Stansfield. Published April 3, 1913.
100. The Building and Ornamental Stones of Canada, by Professor W. A. Parks, B.A., Ph.D. Published October 21, 1912.
104. Catalogue of Publications of Mines Branch, from 1902 to 1911: containing Tables of Contents, and List of Maps, etc. Published March 28, 1912.
110. Bulletin No. 7: Western Portion of Torbrook iron ore deposits, Annapolis county, N.S., by Howells Frechette, M.Sc. Published February 5, 1912.
111. Bulletin No. 6: Diamond Drilling at Point Mamainse, Ont., by A. C. Lane, Ph.D., with Introductory by A. W. G. Wilson, Ph.D. Published June 24, 1912.
118. Mica: Its Occurrences, Exploitation, and Uses, by Hugh S. de Schmid, M.E. Published July 10, 1912.
142. Mines Branch Summary Report, 1911. Published November 2, 1912.
143. Annual Report on the Mineral Production of Canada during the calendar year 1910, by John McLeish, B.A. Published May 15, 1912.
145. Magnetic Iron Sands of Natashkwan, Saguenay county, Que., by Geo. C. Mackenzie, B.Sc. Published June 6, 1913.
150. Preliminary Report on the Mineral Production of Canada, during the calendar year 1911, by John McLeish. Published March 1, 1912.
151. Bulletin No. 8: Investigation of the Peat Bogs and Peat Industry of Canada, 1910-11, by A. Anrep. Published March 31, 1913.
154. The Utilization of Peat Fuel for the Production of Power, being a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910-11, by B. F. Haanel, B.Sc. Published October 9, 1912.
167. Pyrites in Canada: Its Occurrence, Exploitation, Dressing, and Uses, by A. W. G. Wilson, Ph.D. Published March 3, 1913.

181. Production of Cement, Lime, Clay Products, Stone, and Other Structural Materials, in Canada during the calendar year 1911, by John McLeish. Published December 5, 1912.
182. Production of Iron and Steel in Canada during the calendar year 1911, by John McLeish. Published December 11, 1912.
183. General Summary of the Mineral Production in Canada during the calendar year 1911, by John McLeish. Published December 18, 1912.
197. French translation: Molybdenum Ores of Canada, by Dr. T. L. Walker. Published April 18, 1913.
198. French translation: Peat and Lignite, their Manufacture and Uses in Europe, by Erik Nystrom, M.E. Published May 19, 1913.
199. Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals of Canada, during the calendar year 1911, by C. T. Cartwright, B.Sc. Published January 23, 1913.
200. Production of Coal and Coke in Canada during the calendar year 1911, by John McLeish. Published December 26, 1912.
201. Annual Report on the Mineral Production of Canada during the calendar year 1911, by John McLeish, B.A. Published June 4, 1913.
202. French translation: Graphite, Its Properties, Occurrence, Refining, and Uses, by Fritz Cirkel, M.E. Published April 16, 1913.
216. Preliminary report on the Mineral Production of Canada, during the calendar year 1912, by John McLeish. Published March 4, 1913.

ACCOUNTANT'S STATEMENT.

MINES BRANCH.

Statement of Appropriation and Expenditure by Mines Branch for the year ending March 31, 1912.

	Appropriation.	Expenditure.
Amount voted by Parliament	$316,475 00	
Receipts—for assays and analyses	584 30	
Civil list salaries		$49,788 66
Publication of reports		21,316 16
Investigations of iron ore deposits		8,622 08
Zinc investigations		8,062 06
Fuel testing plant, Ottawa		6,820 47
Machinery, labour, etc., peat bog, Alfred		5,184 17
Metallurgical investigations		4,283 22
Investigations of peat and coals		4,670 38
Copper and nickel industry		3,649 77
Concentrating laboratory		3,353 47
Printing, stationery, books, mapping material		3,430 92
Monograph on building stones		2,964 13
Laboratory		2,472 82
Investigations *re* explosives		1,784 55
Wages, outside service		1,502 89
Mining and metallurgical industries		1,554 06
Investigations of copper deposits		1,116 08
Monograph on gypsum		1,014 51
Miscellaneous		834 87
Instruments		703 60
Mineral statistics		513 54
Monograph on mica		302 56
Travelling expenses		214 59
Coal tests		200 51
Publication of maps		119 32
Investigations *re* gas producers		106 65
Balance unexpended and lapsed		182,473 26
	317,059 30	317,059 30

Summary.	Vote.	Expenditure.	Unexpended Balance.
Civil government salaries	$55,575 00	$49,788 66	$ 5,786 34
Investigation of ore deposits, economic minerals, etc.	75,000 00	40,503 45	34,496 55
Printing, books, stationery, apparatus, chemical laboratories' expenses, miscellaneous	70,000 00	29,533 73	40,466 27
Investigation of metallurgical problems of economic importance	5,900 00	4,283 22	1,616 78
Investigation of manufacture and storage of explosives in Canada	60,000 00	1,830 62	58,169 38
Zinc investigations per Bill No. 182	50,000 00	8,062 06	41,937 94
	316,475 00	134,001 74	182,473 26

Appropriation 1909-10.

Balance unaccounted for by J. E. Woodman	100 00

CASUAL REVENUE ACCOUNT.

Sales of peat 1911-12.					
Tons.	Lbs.				
881	1,871	$ 2,583 66			
142		468 60			
1,023	1,871	$ 3,052 26			
40 peat dust......		40 00			
				$3,092 26	
LESS					
Barrett Bros., freight....			$375 18		
Barrett Bros., cartage...			358 07		
A. Anrep, freight.......			9 90	743 15	
					$2,349 11
Sales of publications, 1911-12............					141 83
					$2,490 94

(Signed) **Jno. Marshall,**
Accountant.

APPENDIX I.

Eugene Haanel, Ph.D.,
Director of Mines.

Sir,—I beg to submit herewith, the annual preliminary report on the mineral production of Canada in 1912.

The figures of production for 1912, while subject to revision, are based upon direct returns from mine and smelter operators and are fairly complete.

Special acknowledgments are due to those operators who have promptly furnished reports of their operations during the year.

When complete returns are received the usual annual report will be prepared, containing in greater detail the final statistics as well as information relating to exploration, development, prices, markets; imports, and exports, etc.

I am, sir, your obedient servant,

(Signed) **John McLeish.**

Division of Mineral Resources and Statistics,
February 27, 1913.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA, 1912.

Statistics Subject to Revision.

The total value of the mineral production in Canada in 1912 was $133,127,489 according to the preliminary statistics published herewith, which are based upon direct returns from mine and smelter operators, but subject to final revision. Compared with the previous year this production shows an increase of $29,906,495, or nearly 29 per cent. The mineral output in 1911, however, was somewhat restricted owing to long extended labour disputes, and the largest previous production was in 1910, compared with which that of 1912 shows an increase of $26,243,866, or over 24 per cent. The per capita production in 1910 was $14.93, and this has increased in 1912 to over $18. This record is a gratifying indication or confirmation of the fact that the Canadian mineral industry in 1912 has had by far the most successful year in its history.

This progress is all the more satisfactory because it is evidently due to a widespread and substantial development of the country's mineral resources. The only new camp of importance to contribute largely to the year's output was Porcupine, the gold production of which was about one and three-quarter million dollars. A slight scarcity of labour was reported, particularly in connexion with the asbestos and clay working industries. There were comparatively few labour disputes to interfere with output, the principal difficulties being a strike of coal miners on Vancouver island, beginning in September, and a labour dispute at Porcupine towards the latter part of the year. The total coal and gold production was only slightly affected thereby.

A substantial increase in price in most of the metals, which took place early in the year and continued throughout, had a very important bearing on the year's operations and contributed largely to the increased value of the output.

A feature of particular interest during the year has been the continued and extended development of ore reserves. The satisfactory results from these operations, particularly in the case of the nickel-copper ores of the Sudbury district, the Porcupine gold ores of Ontario, and a number of the copper and lead deposits of British Columbia, point to much greater annual outputs in the future.

Extension of ore smelting and refining facilities and in a number of cases special improvements in methods of practice have also been important factors in the year's operations.

The production of the more important metals and minerals is shown in the following tabulated statement in which the figures are given for the two years, 1911 and 1912, in comparative form, and the increase or decrease in value shown. Tabulated statements in greater detail will be found on subsequent pages of this pamphlet.

	1911.		1912.		Increase (+) or decrease (−) in value.
	Quantity.	Value.	Quantity.	Value.	
		$		$	$
Copper .... Lbs.	55,648,011	6,886,998	77,775,600	12,709,311	+ 5,822,313
Gold .... Ozs.	473,159	9,781,077	607,609	12,559,443	+ 2,778,366
Pig iron .... *Tons.	917,535	12,307,125	1,014,587	14,550,999	+ 2,243,874
Lead .... Lbs.	23,784,969	827,717	35,763,476	1,597,554	+ 769,837
Nickel .... "	34,098,744	10,229,623	44,841,542	13,452,463	+ 3,222,840
Silver .... Ozs.	32,559,044	17,355,272	31,931,710	19,425,656	+ 2,070,384
Other metallic products	....	411,332	....	982,676	+ 571,344
Total		57,799,144		75,278,102	+ 17,478,958
Less pig iron credited to imported ores..	875,349	11,693,721	978,232	14,100,113	+ 2,406,392
Total metallic		46,105,423		61,177,989	+ 15,072,566
Asbestos and asbestic .... Tons.	127,414	2,943,108	131,260	2,979,384	+ 36,276
Coal .... "	11,323,388	26,467,646	14,699,953	36,349,299	+ 9,881,653
Gypsum .... "	518 383	993,394	576,498	1,320,883	+ 327,489
Natural gas	....	1,917,678	....	2,311,126	+ 393,448
Petroleum .... Bls.	291,092	357,073	243,336	345,050	12,023
Salt .... Tons.	91,582	443,004	95,053	459,582	− 16,578
Cement .... Bls.	5,692,915	7,644,537	7,120,787	9,083,216	+ 1,438,679
Clay products	....	8,359,933	....	9,343,321	+ 983,388
Lime .... Bus.	7,533,525	1,517,599	7,992,234	1,717,771	+ 200,172
Stone	....	4,328,757	....	4,675,851	+ 347,094
Miscellaneous non-metallic	....	2,142,842	....	3,364,017	+ 1,221,175
Total non-metallic	....	57,115,571		71,949,500	+ 14,833,929
Grand total	....	103,220,994		133,127,489	+ 29,906,495

*Short tons throughout.

The subdivision of the mineral production in 1911 and 1912 by provinces was approximately as follows:—

Province.	1911.		1912.	
	Value of production.	Per cent of total.	Value of production.	Per cent of total.
	$	%	$	%
Nova Scotia	15,409,397	14·93	18,843,324	14·15
New Brunswick	612,830	0·59	806,584	0·61
Quebec	9,304,717	9·01	11,675,682	8·77
Ontario	42,796,162	41·46	51,023,134	38·33
Manitoba	1,791,772	1·74	2,314,922	1·74
Saskatchewan	636,706	0·62	909,934	0·68
Alberta	6,662,673	6·46	12,110,960	9·10
British Columbia	21,299,305	20·63	29,555,323	22·20
North West Territories	4,707,432	4·56	5,887,626	4·42
Dominion	103,220,994	100·00	133,127,489	100·00

Of the total production in 1912 a value of $61,177,989 or nearly 46 per cent is credited to the metals, and $71,949,500 or 54 per cent to non-metallic products. With the exception of petroleum every important mineral mined in Canada shows an increased production in 1912, in so far as value is concerned. In the case of silver only, is there a decrease in quantity, and this slightly less than 2 per cent, the increase in total value of silver being due to the much higher price obtained for the metal during the year. Among the metals, increases in quantity of output are shown as follows: pig iron 10·5 per cent; gold 28 per cent; copper 40 per cent, and lead 50 per cent. On account of the generally higher prices of the metals the increases in total value of output considerably exceed the increases in quantity, and are as follows: silver 12 per cent, nickel 31 per cent, copper 85 per cent, and lead 93 per cent.

The most important increases among non-metallic products are in coal, gypsum, and cement. Coal shows an increase of 30 per cent in tonnage, gypsum 11 per cent, and cement 26 per cent.

It is a matter of regret to have to report a continued decrease in the production of petroleum. The Canadian output of this product a few years ago was about 50 per cent of domestic consumption. At the present time not over 5 per cent of Canada's consumption of petroleum and its products is derived from domestic sources.

The record of production by Provinces given above, shows some slight changes in the relative importance of the production of each. The only change in the order of magnitude of output is that Alberta, the production of which had exceeded that of Quebec in 1910, but fallen below again in 1911, on account of its restricted coal output, again takes premier place in 1912. Ontario is still the largest contributor to the total, being credited with 38 per cent, or $51,023,134; British Columbia comes second with 22 per cent, or $29,555,323; Nova Scotia third with $18,843,324 or 14 per cent; Alberta fourth with $12,110,960 or over 9 per cent, and Quebec fifth with $11,675,682 or a little under 9 per cent.

It should be remembered in dealing with these comparisons that Nova Scotia in the above record is given no credit on account of the large iron smelting and steel making industries at Sydney, New Glasgow, etc. The pig iron made here is entirely from imported ore and naturally is not credited as a Canadian mine output. The same remark applies to a large percentage of the pig iron production in Ontario as well as to the production of aluminium in Quebec.

There was an increased output in each of the provinces in 1912, the largest gains being in Alberta and British Columbia.

In Nova Scotia both coal and gypsum mining were particularly active though a reduced production of gold is reported. Copper and asbestos mining in Quebec contribute chiefly to the increase in that Province.

Ontario had important increases in nickel and copper, but more especially in gold from the Porcupine district. This Province has a large output of non-metallic products including cement, clays, etc. In Alberta coal mining has had a record year exceeding in tonnage the British Columbia production. In the latter Province the principal increase was in copper, with gold, silver, lead, zinc, coal, and structural or building materials as important contributors.

THE MINERAL PRODUCTION OF CANADA IN 1912.

Subject to Revision.

Product.		Quantity.	Value.
METALLIC.			$
Copper, value at 16·341 cents per pound	Lbs..	77,775,600	12,709,311
Gold	Ozs...	607,609	12,559,443
Pig iron from Canadian ore	Tons..	36,355	450,886
Iron ore sold for export	"	118,129	382,005
Lead, value at 4·467 cents per pound	Lbs..	35,763,476	1,597,554
Nickel, value at 30 cents per pound	"	44,841,542	13,452,463
Silver, value at 60·835 cents per oz	Ozs..	31,931,710	19,425,656
Cobalt and nickel oxides		.....	319,785
Zinc ore	Tons.	6,723	280,886
Total		....	61,177,989
NON-METALLIC.			
Actinolite	Tons..	92	1,000
Arsenic, white	"	2,045	88,726
Asbestos	"	106,520	2,959,677
Asbestic	"	24,740	19,707
Coal	"	14,699,953	36,349,299
Corundum	"	1,960	239,091
Feldspar	"	12,233	25,416
Fluorspar	"	40	240
Graphite	"	2,060	117,122
Grindstones	"	2,912	44,290
Gypsum	"	576,498	1,320,883
Manganese	"	75	1,875
Magnesite	"	1,714	9,645
Mica	"	....	104,393
Mineral pigments—			
Barytes	"	464	5,104
Ochres	"	5,654	30,410
Mineral water		....	169,467
Natural gas		....	2,311,126
Peat	Tons	700	2,900
Petroleum, value at $1·418 per barrel	Bls..	243,336	345,050
Pyrites	Tons..	79,702	348,026
Quartz	"	100,242	195,216
Salt	"	95,053	459,582
Talc	"	8,270	23,132
Tripolite	"	38	230
Total		....	45,171,607
STRUCTURAL MATERIALS AND CLAY PRODUCTS.			
Cement, Portland	Bls..	7,120,787	9,083,216
Clay products—			
Brick, common, pressed, paving		....	7,601,380
Sewer pipe		....	887,641
Fireclay, drain tile, pottery, etc.		....	854,140
Kaolin	Tons..	20	160
Lime	Bus...	7,992,234	1,717,771
Sand and gravel (partial record only)		....	1,066,326
Sand-lime brick		....	882,469
Slate	Sq..	1,894	8,939
Stone—			
Granite		....	1,257,770
Limestone		....	2,820,832
Marble		....	272,236
Sandstone		....	325,013
Total structural materials and clay products		....	26,777,893
All other non-metallic		....	45,171,607
Total value, metallic		....	61,177,989
Grand total, 1912		....	133,127,489

The average monthly prices of the metals in cents per pound for several years past are shown herewith:—

—	1907.	1908.	1909.	1910.	1911	1912.
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Copper, New York.	20·001	13·208	12·982	12·738	12·376	16·341
Lead, "	5·325	4·200	4·273	4·446	4·420	4·471
" London	4·143	2·935	2·839	2·807	3·035	3·895
" Montreal *	4·701	3·364	3·268	3·246	3·480	4·467
Nickel, New York	45·000	43·000	40·000	40·000	40·000	40·000
Silver, "	65·327	52·864	51·503	53·486	53·304	60·835
Spelter, "	5·962	4·720	5·503	5·520	5·758	6·943
Tin, "	38·166	29·465	29·725	34·123	42·281	46·096

* Quotations furnished by Messrs. Thomas Robertson & Company, Montreal, Que.

SMELTER PRODUCTION.

General statistics showing the quantities of ores treated at smelters and the quantities of refined metals or smelter products obtained have been collected by this Branch since 1908. It should be explained that the accompanying statistics include the treatment of a small quantity of imported ores chiefly in the British Columbia smelters.

The total quantity of ores, concentrates, etc., treated in 1912, was 3,008,559 tons, as compared with 2,193,553 tons in 1911.

The ores treated may be conveniently classified as follows:—

	1910.	1911.	1912.
	Tons.	Tons.	Tons.
Nickel copper ores	628,947	610,834	725,065
Silver-cobalt-nickel-arsenic ores	9,466	9,330	8,136
Lead and other ores treated in lead furnaces	57,549	55,408	63,042
Copper-gold-silver ores	1,987,752	1,517,981	2,212,316
Total	2,683,714	2,193,553	3,008,559

The products obtained in Canada from the treatment of these ores include: refined lead produced at Trail, B.C., and fine gold, fine silver, copper sulphate, and antimony produced from the residues of the lead refinery; silver bullion, white arsenic, nickel oxide, and cobalt oxide produced in Ontario, from the Cobalt District ores. In addition to these refined products, blister copper, copper matte, nickel-copper matte, cobalt material or mixed nickel and cobalt oxides are produced and exported for refining outside of Canada.

The aggregate results of smelting and refining operations may be summarized as shown in the next table. Unfortunately the figures cannot be taken to represent the total production from smelting ores mined in Canada, since considerable quantities of copper and silver ores are still shipped to other smelters outside of Canada for smelting.

	1911.		1912.	
	Refined products.	Metals contained in matte blister, base bullion and speiss.	Refined products.	Metals contained in matte blister, base bullion and speiss.
Gold.. Ozs.	15,270	175,189	12,118	184,815
Silver "	19,078,768	585,896	17,877,944	686,171
Lead. Lbs.	23,525,050	..	35,893,190	......
Copper "	....	29,855,868	......	58,405,910
Copper sulphate "	197,187	.....	87,110	.....
Nickel "	..	34,098,744	......	44,841,542
*Nickel and cobalt oxides	1,415,006	.....	1,634,087	......
White arsenic "	4,194,209	....	4,090,756	....

* Nickel oxide, cobalt oxide, and cobalt material, etc., not all completely refined.

Smelter products shipped outside of Canada for refining were: blister copper carrying gold and silver values, 17,069 tons in 1912, as compared with 10,710 tons in 1911; copper matte carrying gold and silver values, 6,727 tons in 1912, as against 11,320 tons in 1911; Bessemer nickel-copper matte carrying small gold and silver values as well as metals of the platinum group, 41,925 tons in 1912, as compared with 32,607 tons in 1911.

Gold.

The gold production of 1912 is estimated at approximately $12,559,443, which compared with the 1911 production, $9,781,077, shows an increase of $2,778,366.

The Yukon placer production in 1912 is estimated at $5,540,000 as against $4,580,000 in 1911, the total exports on which royalty was paid during the calendar year, according to the records of the Department of Interior, being 335,015·67 ounces in 1912 and 277,430·97 ounces in 1911. The British Columbia production in 1912 was $5,167,390, of which the placer production, as estimated by the Provincial Mineralogist, was $500,000, smelter recoveries and bullion obtained from milling ores being valued at $4,667,390. The main feature of the year was the large increase from Ontario due to the commencement of operations by several mills in the Porcupine district, the Province producing $1,745,292 as against $42,625 in 1911.

In Quebec there is a small amount credited to the pyritic ores as well as a small recovery from Beauce county, and the Nova Scotia estimate shows a further decrease.

The exports of gold-bearing dust, nuggets, gold in ore, etc., in 1912, were valued at $10,014,654.

Gold in bars, blocks, ingots, etc., was imported in 1912 to the value of $1,096,546.

Silver.

In quantity there was a slight decrease in the silver production in 1912, returns to date showing a production of 31,931,710 fine ounces, an apparent falling off of 627,334 ounces, but due to the increased price, the value shows an increase from $17,355,272 in 1911 to $19,425,656 in 1912 or $2,078,384.

Of the 1912 production 29,190,122 ounces were from Ontario, 2,651,118 from British Columbia, the increases being from British Columbia and the Yukon.

For British Columbia the figures represent the recovery as mill bullion or silver contained in smelter products, while for Ontario the figures represent the total silver content of ore and concentrates shipped, less five per cent allowed for smelter losses, together with bullion shipments.

The total shipments of ore and concentrates from the Cobalt district and adjacent mines were about 29,116 tons, containing approximately 25,684,082 ounces, in addition to which 4,773,878 ounces were shipped as bullion.

There was also a small silver recovery from the gold ores of Ontario.

In Quebec the silver was derived from the pyritic ores of the Eastern Townships.

The exports of silver in ore, etc., as reported by the Customs Department, were 34,911,922 ounces, valued at $19,494,416. There was also an importation of silver in bars, blocks, sheets, etc., valued at $822,020.

The price of silver in New York varied between a minimum of 54¾ cents per ounce in January and a maximum of 64¼ cents in October, the average monthly price being 60·835 cents, compared with an average of 53·304 cents in 1911.

Copper.

There is practically no recovery of refined copper in Canada and the production is represented by the copper contents of smelter products, matte, blister-copper, etc., together with the amounts of copper contained in ores exported, estimated as recoverable.

The total production on this basis in 1912 was 77,775,600 pounds, valued at $12,709,311, as compared with 55,648,011 pounds valued at $6,886,998 in 1911, an increase in quantity of 22,127,589 pounds and in value of $5,822,313.

Quebec province is credited with a production of 3,225,523 pounds as against 2,436,190 pounds in 1911, the increase being due to the increased production from the pyritic ores of the Eastern Townships. Ontario's production in 1912 was 22,250,601 pounds, as compared with 17,932,263 pounds in 1911, being mainly derived from the nickel-copper ores of the Sudbury district.

Apart from the copper shipments from Dane, the most interesting occurrence was the payment made for copper in shipments from the Cobalt camp.

British Columbia had a record output of 50,526,816 pounds, having had a year of uninterrupted smelter operation free from strikes and other disturbances.

From the Yukon the Pueblo mine was a heavy shipper.

The New York price of electrolytic copper varied during the year between 13·75 cents per pound in February, to 17·60 in August, the average for the year being 16·341 cents as against an average monthly price of 12·376 cents in 1911.

The exports of copper in 1912 were: copper, fine in ore, etc., 76,542,643 pounds, valued at $8,800,276, and copper black or coarse and in pigs, 1,945,921 pounds, valued at $236,212.

The total imports of copper in 1912 were valued at $7,052,534.

Lead.

The total production of lead in 1912 was 35,763,476 pounds, valued at $1,597,554, or an average of 4·467 cents per pound, the average wholesale or producers price of pig lead in Montreal for the year. In 1911 the production was 23,784,969 pounds, valued at $827,717.

The shipments were practically all from British Columbia mines in 1912, a small shipment being made from Ontario mines, but not paid for. Towards the close of the year the North American smelter at Kingston, Ontario, started operations.

In British Columbia the resumption of active operations at the Blue Bell and the activity of the Consolidated Mining and Smelting Company and a number of the more important purely mining companies have been factors in the increase.

The exports of lead in ore, etc., in 1912 are reported as 299,240 pounds valued at $8,193. No pig lead was exported.

The total value of the imports of lead and lead products in 1912 was $1,806,221, including pig lead, bars, sheets, tea lead, etc., valued at $1,202,001; manufactures of lead valued at $200,157; litharge and lead pigments, valued at $404,063.

The total value of the imports of lead and lead products in 1911 was $1,049,276, being pig lead, etc., $706,020; manufactures, $108,012, and litharge and lead pigments, $235,244.

The average monthly price of lead in Montreal during 1912 was 4·467 cents per pound. This is the producers price for lead in car lots as per quotations kindly furnished by Messrs. Thos. Robertson & Co.

The average monthly price of lead in New York during the year was 4·471 cents and in London £17·929 per long ton, equivalent to 3·895 cents per pound.

The amount of bounty paid during the twelve months ending December 31, 1912, on account of lead production was $118,425.74, as compared with $219,557.70 in 1911.

Nickel.

The mining and smelting of nickel-copper ores in the Sudbury district of Ontario was carried on with greatly increased output during 1912. The same companies were in operation as in previous years, viz.: The Mond Nickel Company and the Canadian Copper Company operating mines and smelters, and the Dominion Nickel Company, developing and proving ore bodies. It is interesting to note that small shipments of nickel ore were also made from Alexo mine at Kelso, in the Nipissing district. This ore was smelted at Victoria Mines.

Considerable changes have been made in some of the details of smelting practice, although the general method remains the same, *i.e.*, the ore is roasted, smelted, and converted to a Bessemer matte containing from 77 to 82 per cent of the combined metals, copper and nickel, the matte being shipped to the United States and Great Britain for refining. A portion of the matte made by the Canadian Copper Company is used for the direct production of monel metal, an alloy of nickel and copper, without the intermediate refining of either metal.

The total production of matte in 1912 was 41,925 tons valued by the producers at the smelters at $6,303,102, an increase of 9,318 tons, or nearly 20 per cent over the production of 1911. The metallic contents were: copper 22,231,725 pounds, and nickel 44,841,542 pounds. The amount of ore smelted was 725,065 tons, which included 1,720 tons from the Alexo mine mentioned above.

The aggregate results of the operations on the nickel ores during the past four years were as follows in tons of 2,000 pounds:—

—	1909. Tons of 2,000 lbs.	1910. Tons of 2,000 lbs.	1911. Tons of 2,000 lbs.	1912. Tons of 2,000 lbs.
Ore mined	451,892	652,392	612,511	737,584
Ore smelted	462,336	628,947	610,834	725,065
Bessemer matte produced	25,845	35,033	32,607	41,925
Copper content of matte	7,873	9,630	8,966	11,116
Nickel " "	13,141	18,636	17,049	22,421
Spot value of matte	$3,913,017	$5,380,064	$4,945,592	$6,303,102
	Lbs.	Lbs.	Lbs.	Lbs.
Nickel contained in matte, etc.—				
Exported to Great Britain	3,843,763	5,335,331	5,023,393	5,072,867
" United States	21,772,635	30,679,451	27,596,578	39,148,993
	25,616,398	36,014,782	32,619,971	44,221,860

The price of refined nickel in New York remained practically constant throughout the year, quotations in the *Engineering and Mining Journal* being for large lots, contract business, 40 to 45 cents per pound except during the early part of May, when 40 to 50 cents was quoted; retail spot from 50 cents for 500 pound lots up to 55 cents for 200 pound lots. The price for electrolytic is 5 cents higher.

Iron.

Iron Ore.—Complete returns of iron ore production have not yet been received but shipments from Canadian mines in 1912 were probably about 175,000 tons.

The total shipments of iron ore from mines in 1911 were 210,344 short tons, valued at $522,319, and included 137,399 tons classed as hematite and 72,945 tons as magnetite.

Exports of iron ore from Canada during 1912 were recorded by the Customs Department as 118,129 tons, valued at $382,005. The exports were chiefly from Bathurst, New Brunswick, and Torbrook, Nova Scotia.

Shipments from the Wabana mines, Newfoundland, in 1912, by the two Canadian companies operating there, were 1,331,912 short tons, of which 956,459 tons were shipped to Sydney and 375,453 tons to the United States and Europe.

Pig Iron.—The total production of pig iron in Canadian blast furnaces in 1912 was 1,014,587 tons of 2,000 pounds, valued at approximately $14,550,999, as compared with 917,535 tons, valued at $12,307,125, in 1911.

Of the total output in 1912, 21,701 tons were made with charcoal as fuel and 992,886 tons with coke. The classification of the production according to the purpose for which it was intended was as follows: Bessemer 256,191 tons; basic 544,534 tons; foundry and miscellaneous 213,862 tons.

The amount of Canadian ore used during 1912 was 71,588 tons; imported ore 2,019,165 tons; mill cinder, etc., 36,901 tons. The amount of coke used during the year was 1,265,998 tons, comprising 609,183 tons from Canadian coal and 658,815 tons imported coke or coke made from imported coal. There were also used 1,886,748 bushels of charcoal. Limestone flux was used to the extent of 705,613 tons.

In connexion with blast furnace operations there were employed 1,358 men, and $993,941 were paid in wages.

The production of pig iron by provinces in 1911 and 1912 was as follows:—

	1911.			1912.		
	Tons.	Value.	Value per ton.	Tons.	Value.	Value per ton.
		$	$		$	$
Nova Scotia	390,242	4,682,904	12 00	424,994	6,374,910	*15 00
Quebec..................	658	17,282	26 24	....	....	....
Ontario	526,635	7,606,939	14 44	589,593	8,176,085	13 87
	917,535	12,307,125	13 41	1,014,587	14,550,999	14 34

*The Nova Scotia producers do not place a selling value upon their pig iron production and the increased value used for Nova Scotia pig iron in 1912 does not mean that there has been an increase in the value as shown but that the value used in 1911 was probably too low.

There was also a production during 1912 in electric furnaces of 7,834 tons of ferro-alloys valued at $465,225, as compared with 7,507 tons valued at $376,404 in 1911.

The exports of pig iron during the year are reported as 6,976 tons, valued at $310,702, an average of $44.53 per ton. Probably the greater part of this is ferro-silicon and ferro-phosphorus produced respectively at Welland and Buckingham.

There were imported during the year 272,680 tons of pig iron, valued at $3.512,969, and 19,810 tons of ferro-manganese, etc., valued at $469,884.

Asbestos.

The total shipments of asbestos in 1912 exceeded those of 1911 by at least 5 per cent, it being probable that complete returns will show a somewhat higher production and shipments than the figures given below. According to returns so far received, the total output of asbestos was 97,816 tons, the sales 106,520 tons, valued at $2,959,677, or an average of $27.79, and stock on hand at the end of the year amounting to 21,686 tons, valued at $1,021,066. The record indicates an increase in sales and a reduction of stocks on hand.

Shipments were confined to the mines of the Black Lake and Thetford districts, those at East Broughton remaining idle. Operators report that they were handicapped by shortage of labour but since market prices and conditions have greatly improved, 1913 promises to be a very successful year.

The number of men employed in mines and mills during 1912, was 2,755, at a wage cost of $1,296,655.

The total quantity of asbestos rock sent to mills is reported as 1,514,314 tons, which with a mill production of 97,815 tons, shows an average estimated recovery of about 6·45 per cent.

The following tabulated statement shows the output and sales during 1912, and the stock on hand at the end of the year.

—	Output.	Sales.			Stock on hand Dec. 31.		
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
			$	$		$	$
Crude No. 1	1,447¾	1,928·9	507,904	263 31	864·8	220,789	255 31
" 2	3,224	3,669	372,357	101 49	2,719	293,263	107 86
Mill stock No. 1	19,672	18,758	843,559	44 97	7,490	338,069	45 13
" 2	35,389	43,359	855,902	19 74	6,278	132.349	21 08
" 3	38,083	38,805	379,955	9 79	4,334	36,596	8 44
Total asbestos	97,815¾	106,519·9	2,959,677	27 79	21,685·8	1,021,066	47 08
Asbestic	......	24,740	19,707	0 80	....	....	....

In the absence of a uniform classification of asbestos of different grades the above subdivisions have been adopted purely on a valuation basis; crude No. 1 comprising material valued at $200 and upwards, and crude No. 2 under $200; mill stock No. 1 includes stock valued at from $30 to $100; No. 2 from $15 to $30; No. 3 under $15.

Output, sales, and stocks in 1911 were as follows:—

—	Output.	Sales.			Stock on hand Dec. 31.		
	Tons.	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
			$	$		$	$
Crude No. 1	1,467·9	1,301·4	342,855	263 45	1,256	327,508	260 75
" 2	3,594·5	3,562·7	402,107	112 87	3,222·7	404,198	125 42
Mill stock No. 1	20,379	18,315	916,678	50 05	8,471	380,570	44 93
" 2	39,289	47,826	991,370	20 73	17,794	365,458	20 54
" 3	31,572	30,388	269,052	8 85	3,823	31,367	8 20
Total asbestos	96,302·4	101,393·1	2,922,062	28 82	34,566·7	1,509,101	43 66
Asbestic	....	26,021	21,046	0 81			

Exports of asbestos during the twelve months ending December 31, 1912, are reported as 88,008 tons, valued at $2,349,353, as against 75,120 tons, valued at $2,067,259, exported in 1911.

Coal and Coke.

With the exception of a partial interruption of work, on Vancouver island, during the last three months of the year due to a dispute of coal miners, coal mining was actively prosecuted in all important coal mining districts during 1912. Thus in contrast with 1911 when the output was seriously reduced by a long continued strike in southern Alberta and British Columbia the production in 1912 shows a very large increase.

The total production of coal during the past year, comprising sales and shipments, colliery consumption, and coal used in making coke, etc., was 14,699,953 short tons, valued at $36,349,299, as against 11,323,388 tons valued at $26,467,646 in 1911 and 12,909,152 tons valued at $30,909,779 in 1910. The 1912 production exceeded all former outputs. Nova Scotia shows an increase of nearly 8 per cent. British Columbia an increase of over 26 per cent though not quite up to the 1910 production, Alberta an increase of about 128 per cent over 1911, and 19 per cent over 1910. The other provinces show comparatively little change. The figures for the Yukon represent the production from the Tantalus field, no record having been received of the output below Dawson.

The production by provinces during the past three years is given below:—

Province.	1910.		1911.		1912.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$
Nova Scotia	6,431,142	12,919,705	7,004,420	14,071,379	7,791,440	17,391,608
British Columbia	3,330,745	10,408,580	2,542,532	7,945,413	3,220,899	10,065,311
Alberta	2,894,469	7,065,736	1,511,036	3,979,264	*3,446,349	8,471,126
Saskatchewan	181,156	293,923	206,779	347,248	196,325	327,054
New Brunswick	55,455	110,910	55,781	111,562	42,780	85,560
Yukon Territory	16,185	110,925	2,840	12,780	2,160	8,640
Total	12,909,152	30,909,779	11,323,388	26,467,646	14,699,953	36,349,299

* Statistics furnished by Mr. John Stirling, Inspector of Mines, Alberta.

The exports of coal in 1912 were 2,127,133 tons, valued at $5,821,593, as compared with exports of 1,500,639 tons valued at $4,357,074 in 1911, an increase in exports of 626,494 tons.

Imports of coal during the year included bituminous, round and run of mine 8,491,840 tons, valued at $16,846,727; bituminous slack 1,919,953 tons, valued at $2,550,922, and anthracite, 4,184,017 tons, valued at $20,080,388, or a total of 14,595,810 tons, valued at $39,478,037.

The imports in 1911 were bituminous, run of mine, 8,905,815 tons; bituminous slack 1,632,500 tons, and anthracite 4,020,577 tons, or a total of 14,558,892 tons.

The apparent consumption of coal in 1912 was thus 27,168,630 tons, as against an apparent consumption in 1911 of 24,381,641 tons.

Coke.—The total production of oven coke in 1912 was 1,411,219 tons, valued at $5,352,520, as compared with a production of 935,651 tons, valued at $3,630,410, in 1911. A considerable percentage of this is made from imported coal.

By provinces the production in 1912 was: Nova Scotia 625,908 tons, Ontario 379,854 tons, Alberta 105,684 tons, and British Columbia 299,773 tons, as against a production in 1911 of: Nova Scotia 557,554 tons, Ontario 259,554 tons, Alberta 36,216 tons, and British Columbia 82,327 tons.

The quantity of coke imported during the calendar year 1912 was 628,174 tons, valued at $1,702,856, as compared with imports of 751,389 tons, valued at $1,843,248 in 1911.

Petroleum and Natural Gas.

The annual output of crude petroleum from Canadian oil wells still continues to decline, the production having steadily fallen off during the past five years. Twelve years ago Canada produced about 50 per cent of the domestic consumption of petroleum and its products, while at the present time not over 5 per cent of our consumption is derived from Canadian oil wells. The output in 1912 was 243,336 barrels or 8,516,762 gallons, valued at $345,050, as compared with 291,092 barrels or 10,188,219 gallons, valued at $357,073, in 1911. The average price per barrel at Petrolia in 1912 was $1,418 or considerably higher than the average price in 1911, which was $122⅜.

The price of crude oil increased steadily through the year, rising from a minimum of $1.24 in January to a maximum of $1.65 in the latter part of December.

These statistics of production have been furnished by the Department of Trade and Commerce and represent the quantities of oil on which bounty was paid, the total bounty payments being $127,751.39 in 1912 and $152,823.29 in 1911.

The production in Ontario by districts as furnished by the supervisor of petroleum bounties, was in 1912 as follows in barrels: Lambton, 150,272; Tilbury and Romney, 44,727; Bothwell, 34,486; Dutton, 4,335, and Onondago, 7,115; or a total of 240,935 barrels. This agrees very closely indeed with the production in Ontario on which bounty was paid, viz., 240,657 barrels. In 1911 the production by districts was: Lambton, 184,450; Tilbury and Romney, 48,708; Bothwell, 35,244; Dutton, 6,732; and Onondago, 13,501.

The production in New Brunswick in 1912 was 2,679 barrels, as against 2,461 barrels in 1911 and 1,485 barrels in 1910.

Exports entered as crude mineral oil in 1912 were 18,500 gallons valued at $3,964, and oil refined, 36,945 gallons, valued at $6,147. There was also an export of naphtha and gasoline of 25,791 gallons, valued at $4,261.

The decreased production has been accompanied, particularly during the past two or three years, by a very large increase in imports of petroleum and petroleum products. The total imports of petroleum oils crude and refined in 1912 were 186,787,484 gallons, valued at $11,848,533, in addition to 2,144,006 pounds of wax and candles valued at $119,520. The oil imports include crude oil, 120,082,405 gallons, valued at $3,996,842; refined illuminating oils, 14,748,218 gallons, valued at $1,022,735; gasoline, 40,904,598 gallons, valued at $5,347,767; lubricating oils, 6,763,800 gallons, valued at $1,077,712 and other petroleum products 4,288,463 gallons, valued at $413,477.

The total imports in 1911 were 116,892,689 gallons of petroleum oils crude and refined, valued at $6,009,730, and 1,959,787 pounds of wax and candles, valued at $106,424. The oil imports comprised crude oil, 71,653,251 gallons, valued at $2,188,870; refined and illuminating oils, 13,690,962 gallons, valued at $722,403; gasoline, 23,338,773 gallons, valued at $1,976,032; lubricating oils, 5,308,917 gallons, valued at $806,452, and other petroleum products, 2,900,786 gallons, valued at $315,973.

The principal increases in imports have been in crude oil now used so extensively in British Columbia by the railways and in gasoline.

Natural Gas.—While the production of petroleum has been declining, the output and use of natural gas have been steadily increasing. The southern portion of Ontario has for many years been the principal source of gas, but the Albert County field in New Brunswick is now an important producer, while large developments are taking place in Alberta with such a rapid increase in output of gas that this Province may soon take first place as a producer.

The total production in Canada in 1912 was approximately 15,015 million feet, valued at $2,311,126, and includes 12,534 million in Ontario, valued at $2,045,488, and 2,481 million feet in Alberta, valued at $265,638. New Brunswick returns have not yet been received. The production in 1911 was reported as 11,644 million feet,

valued at $1,907,678, including 10,864 million feet in Ontario, valued at $1,807,513, and 750 million feet in Alberta, valued at $110,165. These values represent as closely as can be ascertained the value received by the owners or operators of the wells for gas produced and sold or used. The values do not represent what consumers have to pay since in many cases the gas is resold once or twice by pipe line companies before reaching the consumer.

Cement.

The statistics of production of cement given herewith will be subject to only slight variation when complete returns have been received. Estimates have had to be made for two firms that had not yet reported, but the totals given are probably within a half of one per cent of the final returns. The record of the past year is of particular interest, in view of the undoubted wide-spread demand for cement. Congestion of freight traffic no doubt militated somewhat against the eastern mills supplying western requirements and in order to relieve the situation the Federal government reduced the duty one-half on importations during the period from June 12 to October 31, inclusive. Statistically the important features of the industry during the year were an increase of over 26 per cent in the Canadian output, an increase of over 116 per cent in imports, and an increase of over 34 per cent in total consumption. Canadian mills supplied 83·2 per cent of the consumption as against 90 per cent in 1911.

The total quantity of Portland cement, including slag cement and natural Portland, made in 1912, was 7,169,184 barrels. The quantity of Canadian cement sold or used was 7,120,787 barrels, valued at the mills at $9,083,216, or an average of $1.27½ per barrel. The total imports of cement were 5,020,446 cwt., equivalent to 1,434,413 barrels of 350 pounds each, and valued at $1,969,529, or an average of $1.37 per barrel. The total consumption of Portland cement, therefore, neglecting a small export of Canadian cement, was approximately 8,555,200 barrels.

Detailed statistics of production during the past four years are shown as follows:—

	1909.	1910.	1911.	1912.
	Bls.	Bls.	Bls.	Bls.
Portland cement sold	4,067,709	4,753,975	5,692,915	7,120,787
" manufactured	4,146,708	4,396,282	5,677,539	7,169,184
Stock on hand Jan. 1	1,098,239	1,189,731	918,965	904,165
" Dec. 31	1,177,238	832,038	903,589	952,562
Value of cement sold	$5,345,802	$6,412,215	$7,644,537	$9,083,216
Wages paid	1,266,128	1,409,715	2,103,838	2,591,090
Men employed	2,498	2,220	3,010	3,379

The average price per barrel at the works in 1912 was $1.27½, as compared with $1.34 in both 1911 and 1910.

The imports of cement already shown included 130,580 barrels from Great Britain, 1,280,958 barrels from the United States, 6,107 barrels from Belgium, 15,857 barrels from Hong Kong, and 911 barrels from other countries. The average price per barrel was $1.37 as against an average value of $1.26 on imports in 1911, in which year the total imports were 661,916 barrels valued at $834,879. These included 190,506 barrels from the United Kingdom, 441,317 barrels from the United States, and 30,093 barrels from other countries.

The consumption of Portland cement in Canada during each of the past five years is shown as follows:—

Annual Consumption of Portland Cement.

Calendar Year.	Canadian.		Imported.		Total.
	Bls.	%	Bls.	%	Bls.
1908	2,665,289	85	469,049	15	3,134,338
1909	4,067,709	97	142,194	3	4,209,903
1910	4,753,975	93	349,310	7	5,103,285
1911	5,692,915	90	661,916	10	6,354,831
1912	7,120,787	83·2	1,434,413	16·8	8,555,200

Exports of Products of the Mine and Manufactures of Mine Products, Year 1912.

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Arsenic	Lbs.	3,847,906	101,310
Asbestos	Tons.	88,008	2,349,353
Barytes	Cwt.	68	114
Coal	Tons.	2,127,133	5,821,593
Feldspar	"	12,779	44,114
Gold		...	10,014,654
Gypsum	Tons.	364,643	423,208
Copper, fine in ore, etc	Lbs.	76,542,643	8,800,267
" black or coarse and in pigs	"	1,945,921	236,212
Lead, in ore, etc	"	299,240	8,193
" pig, etc.	"	...	...
Nickel, in ore, etc	"	44,221,860	4,661,758
Platinum	Ozs.	92	3,821
Silver	"	34,911,922	19,494,416
Mica	Lbs.	895,338	334,054
Mineral pigments	"	6,032,640	34,513
Mineral water	Gals.	9,608	4,667
Oil, mineral, crude, etc	"	18,500	3,964
Oil, refined	"	36,945	6,147
Ores—			
Antimony	Tons.	...	...
Corundum	"	1,928	205,819
Iron	"	118,129	382,005
Manganese	"	10	300
Other ores	"	15,573	530,270
Phosphate	"	...	...
Plumbago	Cwt.	33,074	70,763
Pyrites	Tons.	5,938	11,935
Salt	Lbs.	289,150	3,723
Sand and gravel	Tons.	660,090	459,952
Stone, ornamental	"	2,339	1,826
" building	"	108,516	28,795
" for manufacture of grindstones	"	...	...
Other products of the mine		...	311,851
Total mine products		...	54,349,597

Exports of the Products of the Mine and Manufactures of Mine Products, Year 1912—*Concluded.*

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
MANUFACTURES.			$
Agricultural implements—			
Mowing machines	No.	16,213	562,502
Reapers	"	3,288	195,156
Harvesters	"	15,341	1,634,208
Ploughs	"	13,580	412,460
Harrows	"	4,734	100,579
Hay rakes	"	6,646	199,092
Seeders	"	70	7,040
Threshing machines	"	761	214,499
Cultivators	"	5,059	100,043
All other			1,964,071
Parts of			577,895
Bricks	M.	694	8,493
Cement			2,436
Clay, manufactures of			256
Coke	Tons	57,744	252,763
Acetate of lime	Lbs.	14,691,678	313,262
Calcium carbide	"	7,549,137	230,503
Phosphorus	"	543,620	66,806
Earthenware and all manufactures of			10,001
Grindstones, manufactured			26,535
Gypsum and plaster ground			6,495
Iron and steel—			
Stoves	No.	1,078	15,214
Gas buoys and parts of			83,583
Castings, N.E.S			27,113
Pig iron	Tons.	6,976	310,703
Machinery (Linotype machines)			6,555
" N.E.S			474,996
Sewing machines	No.	24,158	259,617
Typewriters	"	4,025	277,583
Scrap iron and steel	Cwt.	332,641	145,250
Hardware—tools, etc.			91,731
" N.E.S.			48,474
Steel and manufactures of			785,731
Lime			35,097
Aluminium in bars	Cwt.	182,857	2,002,363
" manufactures of			10,898
Metals, N.O.P.			261,752
Naphtha and gasoline	Gals.	25,791	4,261
Oil, N.E.S	"	397,039	119,686
Plumbago, manufactures of			58,920
Stone, ornamental			2,458
" building			163
Tar			76,261
Tin, manufactures of			69,692
Automobiles	No.	3,028	2,013,784
" parts of			105,330
Bicycles	No.	101	9,058
" parts of			54,322
Total manufactures			14,235,689
Grand total			68,585,286

Annual Mineral Production in Canada since 1886.

Year.	Value of production.	Value per capita.	Year.	Value of production.	Value per capita.
	$	$ cts.		$	$ cts.
1886	10,221,255	2 23	1899	49,234,005	9 27
1887	10,321,331	2 23	1900	64,420,877	12 04
1888	12,518,894	2 67	1901	65,797,911	12 16
1889	14,013,113	2 96	1902	63,231,836	11 36
1890	16,763,353	3 50	1903	61,740,513	10 83
1891	18,976,616	3 92	1904	60,082,771	10 27
1892	16,623,415	3 39	1905	69,078,999	11 49
1893	20,035,082	4 04	1906	79,286,697	12 81
1894	19,931,158	3 98	1907	86,865,202	13 75
1895	20,505,917	4 05	1908	85,557,101	13 16
1896	22,474,256	4 38	1909	91,831,441	13 70
1897	28,485,023	5 49	1910	106,823,623	14 93
1898	38,412,431	7 32	1911	103,220,994	14 42
			1912	133,127,489	18 01

APPENDIX II.

LEGISLATIVE ADMINISTRATION OF MINERAL LANDS IN CANADA.

In view of the fact that some misapprehension appears to exist regarding the Federal and Provincial Administration of minerals in Canada, the following brief statement may be of interest.

The minerals in the Provinces of Manitoba, Saskatchewan, and Alberta, and in the Yukon Territory and the North West Territories, are all administered by the Federal Government, as well as coal, stone, gypsum, and other like elements not defined as minerals on lands situated within the Railway Belt in the Province of British Columbia, and within the tract containing three and one-half million acres acquired by the Dominion Government from the Province of British Columbia, situated near the head waters of the Peace river.

These minerals are administered under the following regulations:—

(1.) The Yukon Placer Mining Act, which deals with alluvial mining in the Yukon Territory.

(2.) The Placer Mining Regulations, which deal with alluvial mining on Federal lands outside the Yukon Territory.

(3.) The Quartz Mining Regulations, which deal with rock in place bearing valuable mineral deposits on Federal lands.

(4.) The Coal Mining Regulations, which deal with coal on all Federal lands.

(5.) The Regulations for the issue of permits to mine coal for domestic purposes, which deal with the granting of small areas for the mining of coal.

(6.) The Regulations Governing the Issue of Leases to dredge for minerals in the rivers of Yukon Territory.

(7.) The Regulations Dealing with the Issue of Leases to dredge for minerals in the beds of rivers in Manitoba, Saskatchewan, Alberta, and the North West Territories.

(8.) The Quarrying Regulations, which deal with the issue of leases of lands containing limestone, granite, slate, marble, gypsum, marl, gravel, sand, or any building stone, in Manitoba, Saskatchewan, and Alberta, the North West Territories, the Railway Belt in the Province of British Columbia, and the three and one-half million acres in that Province near the head waters of the Peace river.

(9.) The Petroleum and Natural Gas Regulations, which deal with the issue of leases for that purpose in Manitoba, Saskatchewan, Alberta, the North West Territories, the Railway Belt in the Province of British Columbia, and the three and one-half million acres of land in that Province, also the Yukon Territory.

Copies of these regulations may be obtained on application to the Mining Lands and Yukon Branch of the Department of the Interior.

The minerals in the older provinces of the Dominion (that is in the Provinces of Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island, and British Columbia), are in each case administered by the Provincial authorities. For information respecting minerals in these several provinces, application should be made to the Honourable the Commissioner of Crown Lands for any particular province, at its capital.

SESSIONAL PAPER No. 26a

INDEX.

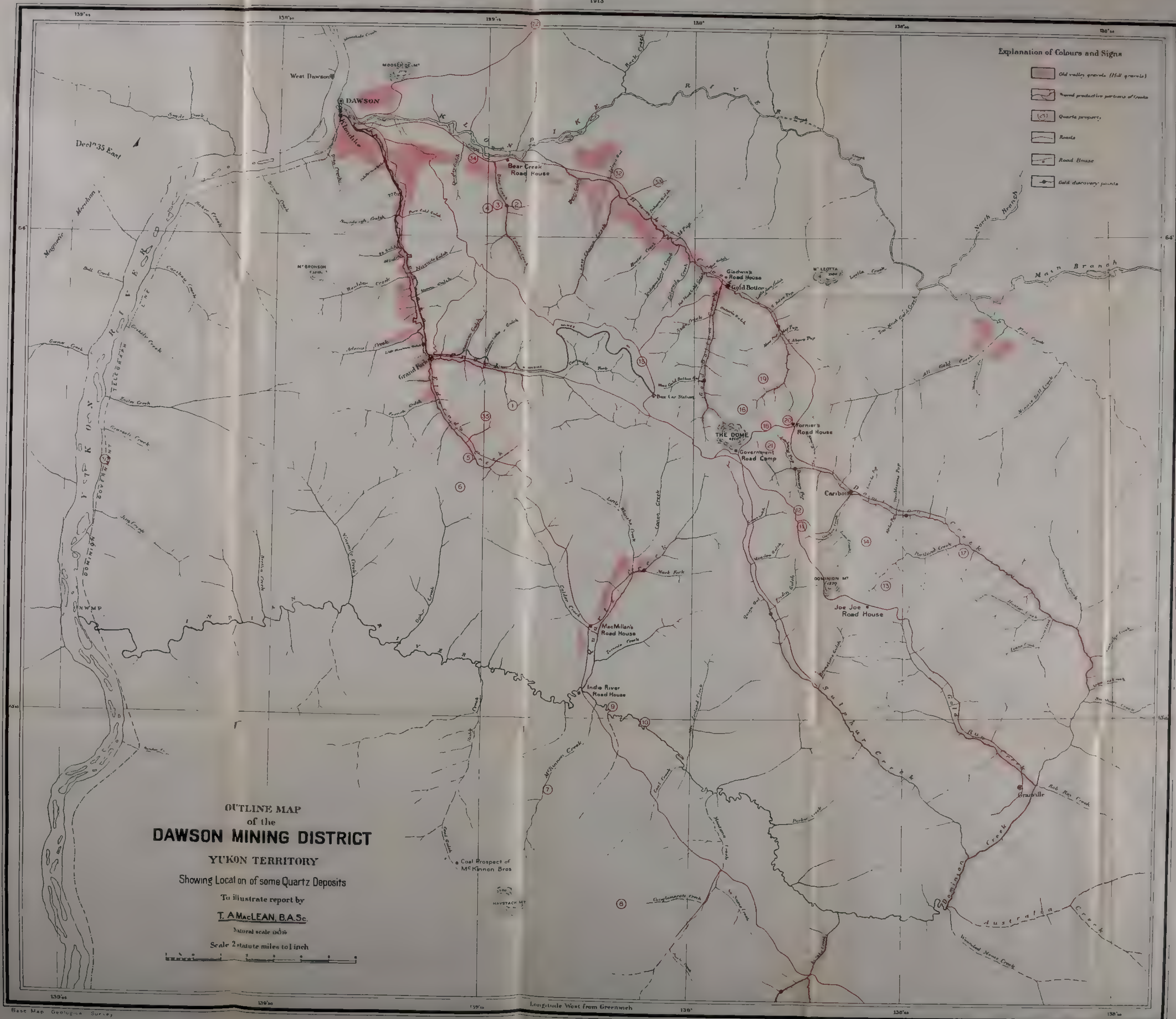
A

B

C

D

CANADA
DEPARTMENT OF MINES
MINES BRANCH
HON. LOUIS CODERRE, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH.D., DIRECTOR.
1913



Reference

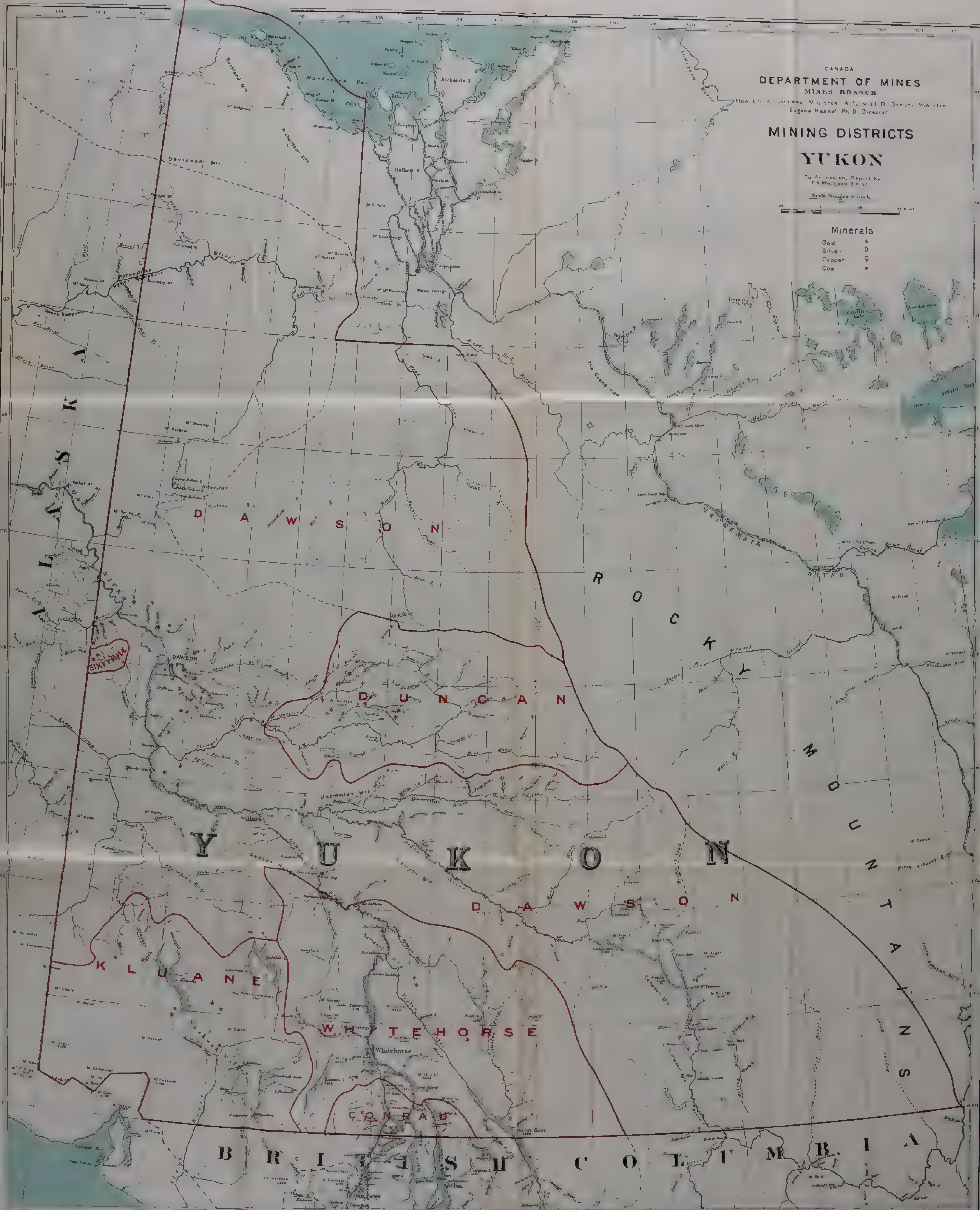
(1) Lone Star Mine
(2) Gordon Mineral Claim
(3) Virgin " "
(4) Jean I " "
(5) Cullen Group
(6) Violet Group
(7) Britannia Group, McKinnon Brothers
(8) Eclipse Group, (Chris Fothergill et al)
(9) Esperanzo Mineral Claim
(10) Raven Mineral Claim
(11) Lloyd Group
(12) Green Gulch Group
(13) Gold Run Group, (W. D. MacKay
(14) Patterson Group, (Flora Mineral [illegible]
(15) Box-Car Group
(16) Mitchell Group
(17) Portland Group
(18) W. D. MacKay Group, Hunker
(19) John Fawcett Claims Hunker [illegible]
(20) Summit Mineral Claim [illegible]
(21) Dome Lode Property
(22) Property of Wels Quartz Mining Co. [illegible]
[illegible] Property of Pickering et al
[illegible] California Girl Mineral Claim
(33) Unexpected Mineral Claim
(34) W. O. Smith Property, on Klondike
(35) Eldorado Dome

Explanations

(1) Nos 23 to 29 inclusive apply to Claims in the Duncan Creek Mining District

(2) No 31 refers to Claims of J. A. Anderson on Excelsior Creek farther south on Yukon than here shown

No 221


CANADA
DEPARTMENT OF MINES
MINES BRANCH
Eugene Haanel Ph.D. Director
MINING DISTRICTS
YUKON
To Accompany Report by T.A. MacLean B.A.Sc.
Minerals
Gold
Silver
Copper
Coal
YUKON
ROCKY MOUNTAINS
ALASKA
BRITISH COLUMBIA
DAWSON
DUNCAN
KLUANE
WHITEHORSE
CONRAD
SIXTYMILE
DAWSON
Whitehorse
Mackenzie Bay
Richards I.
Hallett I.
MACKENZIE RIVER
Davidson Mts
Buckland Mts
Richardson Mts
The Grand View
Smith Bay
Porcupine
Macmillan Mts
Macmillan River
Canyon Mts
Teslin Lake
Atlin
Skagway
220